The Potter's Craft

C. F. Binns

SECOND EDITION

Frontispiece

STONEWARE MADE BY THE AUTHOR.

The Potter's Craft

A Practical Guide for the Studio and Workshop

By CHARLES F. BINNS

Director of the New York State School of Clay-Working and Ceramics ¶ Some time a Superintendent in the Royal Porcelain Works, Worcester, England

SECOND EDITION — THIRD PRINTING

26 PLATES AND 20 TEXT ILLUSTRATIONS

NEW YORK
D. VAN NOSTRAND COMPANY, INC.
250 FOURTH AVENUE

PRINTED IN THE UNITED STATES OF AMERICA

LANCASTER PRESS, INC.
LANCASTER, PA.

"A BOOK is written, not to multiply the voice merely, not to carry it merely, but to perpetuate it. The author has something to say which he perceives to be true and useful, or helpfully beautiful. So far as he knows, no one has yet said it; so far as he knows, no one else can say it. He is bound to say it clearly and melodiously if he may; clearly, at all events."

—*Ruskin.*

PREFACE TO SECOND EDITION

Since the publication of the first edition of this book eleven years have elapsed, years packed full of varied and interesting experiences.

During that time it has been the pleasant fortune of the author to conduct classes, especially summer classes, in the science and art of pottery production. These have been occasions of meeting many fine and noble personalities whom to know is a liberal education. As one of the consequences of these experiences the book has been revised and some new chapters have been written. Especial acknowledgments are due and are gratefully made to Elsie Binns for the chapter on Clay-Working for Children and to Maude Robinson for that on Alkaline Glazes.

The photographs are by the Taylor Studios, Hornell, N. Y.

C. F. B.

Alfred, New York.
March, 1922.

PREFACE TO FIRST EDITION

This Book is the outcome of an experience extending over a period of thirty-six years. Twenty years ago it would have been impossible, for the science of ceramics was not then born. Ten years ago it would have been wasted for the Artist-potter in America had not arrived, but now the individual workers are many and the science is well established.

Written teaching must be imperfect, but I have endeavored to set down the exact methods by which my students are taught, in the hope that those who cannot secure personal instruction may read and understand.

As far as possible didactic statements have been avoided and the attempt has been made to lead every student to experiment and to think for himself. In other words, I have tried to erect sign-posts and occasional warnings rather than to remove all obstacles from the road.

Alfred, N. Y. C. F. B.
January, 1910.

CONTENTS

LIST OF PLATES

INTRODUCTION

The Present Need

MANY times it has been proven, in the history of the world, that it is not possible to force a reform or a novelty upon an unwilling people. Such things are organic. In order to live they must grow and in order to grow must live. No attempt will be made, therefore, in these pages to foster an idea or propound a thought which may exist only in the predilection of the author.

The trend of the present demand, a persistent growth of several years, is towards a personal and individual expression in the crafts or industrial arts. This tendency is the natural swing of the pendulum from the machine-made product of the manufactory which in its turn was the inevitable result of mechanical invention.

When the artisan was an artist and the designer a craftsman, there was but a limited production of industrial art. The articles made were expensive and for the wealthy alone. The common utensils necessary to the household were made on the farm and were of the rudest possible character. But with the gradual development of machinery there came an abandonment of rural activities, a flocking to the city,

manufacturing on a large scale, lower prices, and a huge output. This has, of course, taken many years to develop, but the utmost limit of the swing has been reached and the question is "What next?" Will the factory cease its labors? Will output decrease in bulk and improve in quality? Will there ever, in a word, be a return to medieval conditions? Not only may all these questions be answered in the negative but it may be stated with all sincerity that there is no need for any other answer.

What then, are not manufactured products as now put forth a menace to the art life of the nation? Are not the people being educated in the use of and belief in machine-made ornament and meretricious display? Perhaps so, but no good purpose will be served by a ruthless condemnation of these things. Art appreciation is a most subtle thing and no one may dictate to his neighbor as to what he should or should not admire. It took time for the public to understand and patronize the product of the machine even though the price was favorable. It will take time for an appreciation of craftsmanship to influence the land but this consummation will most assuredly come.

On the one hand there is the manufactory, teeming with "hands," riotous with wheels, turning out its wares by the thousand and supplying the demand of the many; on the other, there is the artist-artisan. He labors at his bench in sincere devotion to his

chosen vocation. His work is laborious and exacting, he can make but a few things and for them he must ask a price relatively high. Both these conditions are necessary. The craftsman cannot supply the need of the people and the manufacturer has no time or thought for disinterested production. Herein lies the need and here is the mission of the individual worker.

In every age it is given to some to discern more than the multitude and it is theirs to teach. The people are anxious to learn, are eager to be led. What they demand will be manufactured and so by the irresistible lever of public opinion the man at the bench, if he be true to himself and to his craft, may move the millionaire manufacturer to make wares which, if not truly artistic, shall at least be inoffensive. Such a mission is not to be accomplished without suffering. The man who essays to attack a giant must be sure both of his ground and of his personal condition. He who would establish his craft in the knowledge and affection of men must possess enthusiasm, skill, discrimination and infinite patience.

It is not enough to discern the good, the hand must follow the brain with diligent care. Furthermore, it is not enough to be able to make things well, one must also make them good and know it. The artist-artisan must have courage to destroy that which is below standard, and self-denial to resist the temptation to sell an unworthy product.

The country needs craftsmen of this type and for them there is an important work. For such, if they elect to join the ranks of the potters, these words are written and in the hope that some may be stimulated, encouraged, guided and helped the counsel of a fellow craftsman is offered.

The Potter's Craft

CHAPTER I

Applied Art

IT is not intended, in these lines, to consider what are generally termed the Fine Arts, painting and sculpture. These are perfectly competent to take care of themselves and, indeed, the author can make no claim to an ability to discuss them. In the field of applied art, however, there are certain principles to be observed, principles, moreover, which are frequently lost sight of because of the lamentable separation of the functions of the artist and artificer.

It is extremely difficult to draw the line between art and manufacture. For example, a wall paper, designed with skill and executed by machinery in actual reproduction of the work of the designer; is it a work of art or is it a product of the factory? It is both. Primarily a work of art is the product of the artist's own hand. It reveals his individuality. It is the language in which he expresses himself to his audience. It is the note of his voice. Such a work may or may not appeal to a large section of the public. This will always be so. An artist, be he poet, musician, painter or craftsman, is one who can see more than others. What he sees he endeavors to express

but it is inevitable that he be sometimes misunderstood. Hence it the more necessary that his message be delivered at first hand. To look upon a replica of the work of an artist is like reading a sermon or an oration from a printed page. One may gather much of the teaching but the personal note, the tone and gesture, must be lost.

But there are many who can gather the words of great men only from books. There are, moreover, books which have never been spoken and wherein alone the message is to be found. In like manner there are works, emanating from the hand of great designers which can only be made available for the many in a form of reproduction. The wall paper cited as an illustration is of this class. Were it not for the printing press this beautiful design could not have passed beyond the studio, and while it is a great thing if a wealthy man can commission a Whistler to decorate a peacock room, it is an advantage by no means to be ignored that a well designed wall paper can be purchased by the piece.

But while this is true of such of the household goods as cannot be procured except by the medium of the machine, there are other examples. In the case of the wall paper the function of the machine is simply to transfer the proper design to the paper itself. This has no identity except as a surface. It is no more to be considered than is a canvas upon

which a picture is painted. But when a chair or a table is formed out of pieces of lumber uniformly shaped by one machine, the seat or top put together by another and the legs or back carved or stamped by a third, art or individuality is lost because mechanical construction is involved.

Still more is this the case in the product of the manufactory of pottery. In commercial practice not only is a shape designed without regard to decoration but the same decoration is placed upon several forms, or a single form is made to suffer as the vehicle for many decorations. Some of the results may be pleasing, even beautiful, but it is more by luck than guidance and no piece produced in this way has any claim to be classed as a work of art.

On the other hand it may happen that a work of art, in the sense of individual expression, may not even be beautiful and one is tempted to ask the reason. If a work which is a genuine expression of a man's personality fail to please the senses of those who are trained in the finer perceptions there must be something wrong.

If the adverse opinion be at all general amongst the critics it may be assumed that they are right and that the worker is wrong.

For example, the form of a flower is not a fit receptacle for a candle. It often happens that a designer, struck with the beauty of, say, a tulip, has

modeled the flower in clay and made it into a candlestick. Now it is obvious that the more closely the model simulates the flower the less appropriate it is for such a purpose. If the model be heavy enough to be of use it must be far removed from its prototype. If a conventional design for a candlestick be adopted the petals of a flower may be shown in relief upon it but there must always be a solid foundation to account for the possibility of use.

A favorite form with some designers is a bird's nest made into a flower holder. In this the same criticism applies. A bird's nest is always built to let water escape. Even a mud-lined nest is not impervious and the idea is obviously inappropriate. It is important that imitation be avoided and especially the imitation of material. One often hears the remark "How beautiful, it looks just like bronze." This, of course, comes from the casual observer to whom the skill of the imitation appeals but it cannot be too strongly insisted upon that to imitate one material in another is false from every point of view. Nor is it necessary. Clay is sufficient in itself. There are so many effects possible in pottery which are not possible in any other medium that it is entirely superfluous to seek outlandish texture and color. To be sure, such things are popular but that does not make them sound in principle or true in taste.

The Potter's Craft

It should not be a purpose of any craft to make pieces merely as an exhibition of skill. This is done sometimes by such versatile workers as the Japanese, but it may be laid down as a law that a production of the nature of a *tour-de-force,* an object which simply excites wonder at the skill of the worker, is undignified and meretricious. It is akin to the work of certain painters who delight in painting marble or velvet so as to exhibit a perfect texture only and is but one degree removed from the skill of the pavement artist who with colored chalk draws a lamb chop or a banana in such a manner that the real article seems to be lying on the ground at his feet.

The true artist, be he potter or painter, works primarily for his own satisfaction. It sometimes happens that a defect, not large enough to be obvious, is a temptation to concealment. The public will never know. But the consciousness of the existence of such a blemish will destroy the pride of achievement which should accompany every finished piece.

If the worker aim to draw any expression of opinion from the untrained observer it should be in the nature of a remark on how easy the work looks. Art will always conceal effort. Just as the poet or orator is at his best when he clothes sublime thought in simple words so the artist or craftsman glorifies his vocation when he makes use of means which appear to be within the reach of every observer.

In addition to the work of the producer there must be considered the function of the critic. Artists are commonly impatient of criticism. Tennyson voiced this sentiment when he wrote of "Irresponsible indolent reviewers," but the power of the critic is rarer than the skill of the craftsman. True, there are critics and critics. There is the man who knows what he likes and who cannot be persuaded that he likes what is false, and there is the trained critic who sees with an educated eye and dissects with an unerring word. It is not common to find critic and craftsman in one and the same person and it not infrequently happens that the persons exercising these functions are at variance with each other.

But if the critic be correct why is the craftsman wrong? In this let it be presumed that there is nothing wrong with his craft as such; that he handles his tools skilfully and has perfect control over his material. More than this, however, is necessary. The first requirement is a sense of form, a term which includes outline, proportion and structure. Often and often it is found that a designer depends upon novelty alone for acceptance. He is not altogether to blame in this for the great American public will, more often than not, ask, "Is it new?"

Novelty in itself is no claim to consideration; in fact, on being shown some product of which it is said "Nothing like it has ever been seen before," the

temptation is great to respond, "May its like never be seen again." Novelty apart, form must possess proportion, balance and grace. A chair must invite the sitter, a vase must stand securely, a carpet must lie flat. The absence of these things may evidence an individuality on the part of the designer but it is art at the expense of truth.

The second necessary condition is fitness which again is expressed in several ways. A porcelain vase is required to be light, graceful and refined. A piece of ruder pottery may be no less satisfactory if it exhibit vigor, strength and solidity. A large pot for a growing tree is, for these reasons, more appropriate in grès than in porcelain. Porcelain is translucent but such a quality is of no advantage in the case of a flower pot; the strength of a massive body is, however, demanded by the circumstances of use and hence the unfitness of the one and the fitness of the other.

Another point of fitness is concerned in the correspondence between size, form and weight. It often happens that one takes hold of a piece of pottery and experiences a shock. The mind unconsciously forms an estimate of what the weight will be but the piece does not respond. The effort put forth in accordance with the appearance of the object either lifts it suddenly into the air or fails to raise it from the table. The artist critic takes note of these things. To handle his wares is a constant pleasure, for one is not con-

tinually disappointed by unexpected violences. This correspondence or equilibrium is apart from the use of a piece of pottery. It is quite as legitimate to express one's ideas in clay in the presentation of simple beauty as it is to express them with paint upon canvas. At the same time there is always a satisfaction in a vase or flower pot that it can be used if required. Thus a vase which will not hold water is technically imperfect and the *bête noire* of the conscientious potter.

It is in the harmony of these things that the rôle of the critic is seen to advantage. If the artist be capable of criticizing his own work he is in a position to command attention but he must either discipline himself or be disciplined by others, which, after all, is the way of the world at large.

CHAPTER II

Pottery

IT must always be an open question how much credit for artistic feeling can be given to primitive races. The production of pottery was, at first, the supplying of a need. Clay offered a medium for the making of household utensils which were at once fireproof and impervious. The work does not belong strictly to the earliest stages of civilization but is a development of advancing refinement.*

Crude and unprepared clays were used for the most part but the makers could scarcely have been conscious of the charming color-play produced by the burning of a red clay in a smoky fire. The pottery of the Indians is artistic in the sense of being an expression of an indigenous art and much of it is beautiful, though whether the makers possessed any real appreciation of beauty is open to doubt.

The pottery was exclusively the work of the women. No wheel was employed but the ware was mainly

* Those who wish to study Indian pottery in detail are referred to Dr. W. H. Holmes' work on the Aboriginal Pottery of the Eastern United States, published by the Smithsonian Institution, Washington, D. C.

constructed by coiling. Long strips of clay were rolled under the hands and made of uniform size and these were then coiled in spiral form, the rolls being welded together with water. After proceeding a certain height the walls of the growing jar would become weak under their own weight. The piece would then be set aside to undergo a partial hardening upon which the work would be carried forward another stage. The shape being completed and partially dried, the maker would work over the whole surface with stones or simple tools until the marks of the coils had disappeared and the walls had reached a sufficient thinness. A great deal of skill was exercised in accomplishing this.

Many of the Indian forms are transitional. The basket, the gourd and the bark-made jar suggested their shapes to the potter; indeed it is sometimes evident that clay vessels were constructed as linings to wicker forms, the outer layer of twigs being afterwards burned off. The firing was performed in the open flame without any protection, a fact which accounts for the great irregularity found in quality and color.

The decorations used by the Indian women were of the type common to unglazed wares. The clay was incised or embossed and natural earths were used as pigments. This accounts in great measure for the fitness which may be observed in aboriginal decoration.

There is an absence of artificial coloring, nor is there any straining after effect, but instead there is shown a sober strength and a sane expression of values which would do credit to a modern designer.

America is fortunate in possessing abundant relics of primitive times but it cannot be doubted that in other lands similar work was done, making allowance, of course, for the characteristic variations in national traits. The potter's craft is of such a nature, using an omnipresent material and requiring the minimum of tools, that almost every nation on the globe has practiced it. In some it has never been developed beyond the narrow limits of the stone age, in others it has reached the utmost perfection of cultured skill.

For perfection of quality in crude pottery, no ware has ever surpassed that of Greece. It is not practicable here to deal with the numerous branches and sub-branches of Greek pottery; let it suffice for the present purpose to speak of only two main groups. In the first, the background of the decoration was supplied by the tint of the bare clay; in the second, this tint afforded the color of the decoration itself, the background being covered with a black pigment. To speak briefly these groups are known as black-figured and red-figured wares.

The wheel was early adopted by the Grecian potters as a means of producing form and although molds

were sometimes used, the wheel was, to all intents and purposes, the sole method of manufacture. Greek pottery is once fired. Birch classes it as glazed terra cotta, but the glaze is nothing more than the black pigment with which the decoration is carried out. The uncolored part of the clay is not glazed but polished with a hard tool. Probably some famous potters employed assistants either to make the pieces or to decorate but it does not appear that there was any reproduction, at least, during the best period. At first primitive ideas prevailed. Geometric designs were succeeded by rhythmic friezes of beasts and birds done in black. When the human figure made its appearance the faces were all in profile with full-fronting eye while the prominent details of feature and drapery were scratched with a sharp point before burning.

The change of method to red on black gave much wider scope for the treatment of the human figure, rendered a fuller expression possible and enlarged the power of pictorial action. Great skill in drawing was manifested and details of both drapery and features were expressed with great care by means of the brush.

Such was the state of the art when the decadence set in and the work fell into the hands of plagiarists and charlatans. Meretricious coloring and gaudy ornament succeeded the refinement and restraint of the earlier days and so the art perished.

To the inventive power of the Romans the ceramic art owes more than one novelty. It would appear that the desideratum of the early days was a black ware. Homer in his hymn wrote:

"Pay me my price, potters, and I will sing.
Attend, O Pallas, and with lifted arm protect their ovens,
Let all their cups and sacred vessels blacken well
And baked with good success yield them
Both fair renown and profit."

The Greeks accomplished this blackening by means of a pigment, the Romans secured a similar result by a manipulation of the fire.

It is well known that the oxide of iron which imparts to the clay a red color will, if burned in what is known as a "reducing" fire, turn black. This is accomplished by keeping the air supply at the lowest possible point and the effect is heightened by the smoke which is partly absorbed by the clay. This black ware is known as Upchurch pottery from the name of a locality in England where large quantities have been found, but numerous examples occur in Germany and, indeed, wherever the Roman hosts encamped.

A second type of pottery is called Castor ware and consists of a dark clay upon which the decoration is

traced in clay of a lighter color. The decoration was applied as a slip or cream and hence was the forerunner of the modern slip painting or *pâte-sur-pâte*. This ware is well worth a study. The decorations consisted largely of conventional borders and panels but it is specially notable on account of the free use of motives drawn from daily life. One of the commonest scenes depicted is the hunt of hare or stag, the animals and trees being often woven into an almost conventional frieze.

The most valued type of Roman pottery seems to have been the Aretine or Samian ware. This is a bright red color and possesses an extremely thin glaze. A particular clay was evidently used, but all knowledge of its source has been lost.

With the importation of Chinese porcelain by the Dutch the whole trend of pottery manufacture was changed. No longer was black a desirable color, white was seen to be much more delicate and beautiful and henceforth the endeavor of the potter was to produce a ware which should be as nearly like porcelain as possible. The crudeness of the clay kept this ideal from being realized, but various expedients were adopted and gradually better results were obtained.

Throughout the East a type of white pottery was made which, though stimulated by the Chinese example, may have been a relic of the knowledge of the Egyptians. A crude clay was coated with a white

preparation, possibly ground quartz, and upon this there were painted conventional designs in sombre colors. A clear glaze covered the whole and imparted to the colors a beautiful quality as of pebbles under water. The nature of the glaze is made evident by the hues assumed by the metallic oxides employed as colorants. Copper oxide affords a turquoise blue, manganese, a wine purple, and iron, a brick red. If the glaze had contained any considerable amount of lead oxide, these colors would have been quite different; copper would have produced green, manganese, dark brown, and iron, yellowish brown. The iron pigment was evidently a clay, sometimes spoken of as Armenian bole. The red color is always in raised masses because if a thin wash had been used the color would have yielded to the action of the glaze.

This ware, commonly called Oriental *engobe* ware, affords a fruitful study. Effects similar in character were produced by the late Theodore Deck of Paris, but no considerable use of the ancient methods has ever been attempted.

The use of tin and lead in glazing was known to the Arabian and Moorish potters but these ingredients were not abundant in the East. When, however, the Moorish hosts conquered a part of Spain in the twelfth century it was found that both lead and tin were available. The result was the development of the enameled ware known by the generic name Maiolica.

Some have maintained that this was first made in Italy but the name is derived from the island of Maiorca from which much of the pottery was exported. The famous Alhambra vase remains as a monument to the skill of the Hispano-Moresque craftsmen, but it was the Italian artists of the Renaissance who brought the enameled wares to perfection. The interest here is artistic and technical rather than historical, but no one can study the work of the period without learning something of Luca della Robbia and Giorgio Andreoli, of Gubbio and Pesaro and Castel Durante.

The use of lead in the glaze proved seductive. It simplified the technical problems and provided a brilliant surface but alas! the colors suffered and one by one they succumbed. The blue of cobalt, however, proved indestructible and so, when the technical knowledge of the South met the traditions borrowed from the Chinese, there was born, in the little town of Delft in Holland, the blue enameled ware which has ever since been known by the name of its native place.

As to the technical details of the production of Delft ware a great deal of information is available. The clay used contained a goodly proportion of lime and this served to hold the enamel in perfect union with the body. The decoration was painted in cobalt blue upon the unburned surface of the enamel. This was, in a measure, courting a difficulty but it is the

glory of the craft that a difficulty is cheerfully accepted if in the overcoming there is found success. If the Delft potters had burned their enamel in order to make the painting easy, the world would never have enjoyed the tender tone of blue for which this pottery is famous. By painting the blue color over the powdery enamel, a more perfect union of enamel and color was accomplished than would have been possible by any other means. This fact alone is sufficient to account for the unsatisfactory nature of the modern, so-called, Delft. Difficulties have been avoided rather than met and the success of the early masters has eluded their recent followers.

Much of the pottery made in France in the seventeenth century was inspired by the Italian renaissance. In fact the word faience is due to the avowed intention of the manufacturers of Nevers to copy the enameled pottery of Faenza. Almost the only novelty of the time was the inversion, by the Nevers potters, of the Delft idea. Instead of a white enamel with a blue decoration they used, in part, a blue ground with a decoration in white. It is not known that this variation found acceptance in any other place but in many localities, notably at Rouen, the manufacture of enameled wares was pursued with great success. The only real difference between the wares of Spain, Italy and France, lies in the decorative treatment. Sometimes the emphasis was laid upon lustres, sometimes on blue

and white and again upon polychrome painting. In one place there was an extensive use made of pictorial treatment, in another all was conventional. The differences are interesting to a student or a collector but to the craftsman enameled pottery affords but one, though by no means an unimportant, means of expression.

France, however, gave birth to two important and interesting departures from the beaten track; the so-called Henri deux ware, and the faience of Bernard Palissy. Important as these are to the ceramist, it is a remarkable fact that neither of them had any appreciable influence upon the art as a whole nor did they leave any descendants.

A good deal of controversy has raged around the pottery commonly known as Henri II, some authorities claiming that it should be called Faience d'Oiron, and others assigning to it the name Saint Porchaire. It was, quite evidently, the production of an individual or group of individuals who had no connection with ordinary pottery manufacture, and the small quantity produced is evidence that it was made for personal pleasure. The name Henri II is undoubtedly satisfactory, for it was made in the reign of the second Henry and some pieces bear the monogram of the king. On the other hand H may be the initial of Helene d'Hengest, who occupied the chateau d'Oiron and who had in her employ one Bernard who filled

the position of librarian. The style of the work seems to indicate a devotion to books, for the patterns are suggestive of book-binding tool work but were not produced in the same way. The ware was made of a natural cream-colored clay and the shapes were modeled with great skill. Upon the plain surface patterns were tooled or incised and the hollows thus formed were filled in with dark-colored clays. The whole was then covered with a clear lead glaze which afforded a finish very much like modern earthenware.

The origin of this work is a matter of little more than academic interest but the technical details are of such importance as to be well worth a study. The ware is original and unique. No pottery either before or since has approached it in method, and the quality of most of the pieces is all that could be desired. Such was the elaboration of detail that no price could have been set upon the ware and it was evidently not made for sale. A distinct growth in style can be traced. The first pieces were somewhat archaic and even crude but as skill was acquired greater perfection was attained. As is too often the case, however, the skillful hand overreached itself and the later pieces are loaded with meretricious detail in many colors. There are only about fifty pieces known and these are equally divided between the museums of France and England.

Bernard Palissy was a versatile genius but is here only considered as a potter. He states in his records that he was inspired by seeing an enameled cup. It was at one time supposed that this cup was of Italian maiolica but later authorities incline to the belief that it was a piece of Chinese porcelain which Palissy supposed to have been enameled. No white clay was known to him but enameled wares were quite accessible. It can scarcely be believed that maiolica was a novelty but it can easily be understood that a piece of white porcelain, viewed in the light of the contemporary knowledge of enamels, would appear of marvellous quality.

Palissy essayed to imitate this wonder but attacked the problem from the standpoint of an opaque glaze. He spent fifteen years in experimenting but never realized his ideal. He did, however, produce a palette of marvellous colored enamels. He was a close student of nature and modeled all kinds of natural objects, glazing them in the proper hues. He also designed and made vases and service pieces, some with figure embossments. The story of his struggles is readily accessible to any who are interested.

Palissy left little or no impression upon the ceramic art of his time but in recent years some work has been done in colored glazes fusible at a low temperature. This ware is sometimes sold under the name of maiolica but it is more nearly an imitation of Palissy.

The main difference between the two types is that while the maiolica or tin-glazed pottery of Spain, Italy and France consisted for the most part of a white enameled surface upon which painting was applied, Palissy used little or no white enamel but decorated his wares with tinted glazes which themselves supplied the colors.

In the low countries and the German states there was made the striking and original pottery known as *Grès de Flandres.* The clay was of the type commonly used for the manufacture of stone-ware and appears in three colors, brown, gray and cream. The ware was made on the wheel and embossments more or less elaborate were subsequently added. The unique feature consisted in the method of applying the glaze. This was simply common salt, thrown into the heated kiln and volatilized. The salt vapor bathed the glowing pottery and combined with its substance, thus producing the delightful orange-skin texture known as salt glaze.

The knowledge of this method was conveyed to England in the seventeenth century and gained wide acceptance there. The English potters preferred to use clays which were almost white, and after glazing a decoration in brilliant colors was sometimes added. Naturalistic treatment was not attempted but conventionalized subjects were used with almost the effect of jewelry. The temperature at which this work can

be produced varies with the clay. Many fusible clays will take a salt glaze but the beauty of the product depends to a large extent upon the purity of the body. This necessitates a hard fire, for white-burning clays always need a high temperature for vitrification. The early potteries of England were dependent largely upon clay effects. Some little enameled ware was made and is known as English Delft; but the bulk of the work was slip painted, incised, marbled or embossed. Each of these methods is capable of an intelligent application and all are within the reach of the artist potter.

CHAPTER III

Porcelain

THE production of porcelain is the goal of the potter. The pure white of the clay and the possibility of unlimited fire treatment exert a profound influence upon the imagination while the difficulties of manipulation only serve to stimulate the energy of the enthusiast. For present purposes not much is to be learned from the soft porcelains of France nor from the bone china of England. German and French hard porcelain are but developments of the Chinese idea and therefore need not be studied apart from their prototype.

The earliest date of Chinese porcelain is unknown. The records of the nation are very ancient but their meaning is often obscured by the fact that in the Chinese language the same word was used of old to denote both porcelain and earthenware. Specimens dating from only the tenth century A. D. look almost incredibly old. They are coarse and heavy in structure but are aglow with vibrant color. The finest porcelains date from the fourteenth and fifteenth centuries and these are the ideals towards which every modern potter looks.

Broadly it may be stated that two methods prevailed. In the former the glaze itself was charged with color or the coloring matter was applied to the clay beneath the glaze. In the latter the porcelain was finished as to body and glaze and the decoration was applied at a subsequent and much lighter burn.

The first named class is called single-colored porcelain; the second has several names such as the famille rose and famille verte as defined by Jacquemart.

In the single-color class it is evident that the potters were not at all sure of their results. In many museums there are to be found examples of ox-blood red, more or less fine, and, with them, other pieces which were intended to be red but which failed in the fire. The wonder is, in these cases, that the pieces, even though failures, are beautiful. The knowledge required for the production of these wares is largely scientific; at the same time it is not to be believed that the Chinese had any special scientific training. They evidently traveled a long and tortuous path before the goal was reached, in fact, they often fell short of it altogether, but they had plenty of time and unlimited patience. The modern potter is, if less patient, more fortunate in that the course has been marked out with more or less accuracy and, if the landmarks of science be heeded, a certain degree of success may be attained.

This single-color work is the true field of the ceramist. Anyone possessing the power of using a pencil, and with a large stock of patience, may produce over-glaze decoration, but to prepare glazes of many hues and to consign them unprotected to the fury of the furnace, requires skill, patience, courage and enthusiasm.

During the last twenty years a new school has arisen which combines in a measure the advantages of the two Chinese methods. Colors are prepared from refractory materials and upon clay or soft burned biscuit ware, scenes, in more or less conventional form, are painted, or else a design purely conventional in character is applied by the artist. The ware is then glazed and subjected to the severe fire which all porcelain undergoes. The result is that the porcelain and the painting are united in a sense that can never be the case with over-glaze treatment. The colors become part of a purely ceramic unit; the spirit of the artist is fixed by the fire.

To this class belong the porcelain of Copenhagen and the recent product of Sevres. These, of course, represent the result of much arduous training and many tedious experiments. Both the training and the experiments are necessary to some extent for every worker, not only because pottery clays vary much in composition, but because individuality can only be

obtained by the preparation, in the laboratory, of the desired compounds.

The Chinese, doubtless, stumbled upon many of their successes by accident, helped by the fact that the character of the fire employed influenced many of their colors. This will be explained in a later chapter. They were, however, quick to seize upon that which was good. Many fanciful names were given to the rarest colors, such as "the violet of wild apples," "liquid dawn" and "the red of the bean blossom." This idea has been carried further in France by the invention of such names as *"Sang-de-boeuf," "Sang-de-poulet," "clair-de-lune,"* etc., and pursued in this country in "Peach blow."

In the over-glaze treatment, the type named "famille verte" is characterized by a clear green glaze or enamel over a design in black. The whole is painted over the porcelain glaze and the green enamel is so soft that it is often decomposed on the surface. When a broad black mass is covered with green the decomposition gives rise to prismatic colors and occasions the term "raven's wing black." Some of this ware has also been gilt but the gold lines have disappeared and can only be located by the slight dullness of the enamel where they once were. Well known to collectors also are the rose-back plates. These belong to the "famille rose" in which the characteristic note is a delicate rose pink. This color

is prepared from gold and when it is placed upon the back of an egg-shell plate a tender rosy transparency is imparted to the piece. One of the best known of the single colors is the pale sea green named celadon by the French. This color in China was called "the sky after rain" and was considered both rare and valuable.

The porcelain of Copenhagen is the product of scientific skill and artistic taste. In the studios attached to the Royal Manufactory there has grown up a tradition of work and criticism which is fostered by ladies of birth and position. Many of these paint upon the porcelain themselves and so constitute a school which has become world famous.

Natural objects are, for the most part, chosen and, as the palette of colors is, owing to the intense fire, quite limited and low in key, a tone of quiet atmosphere pervades the painting. This is accentuated by the use of the air-brush to distribute a ground color upon the ware in graduated strength.

At the National Manufactory of Sevres there has been some attempt to follow the Copenhagen method but to a greater extent the work is along the lines of conventionalized form. In this treatment the French artists excel, being wonderfully accurate—almost too accurate—in their lines and spacing. Several individual workers in France have also pursued this plan,

designing and executing the pieces which have made the French artist-potters famous.

In the porcelains of Berlin the quality lies largely in the complete mastery of technical details. The work is, as would be expected, German in style, but the paste is pure and the colors are well prepared.

From this brief review it will be seen that the interest in the manufacture of porcelain lies not so much in variety as in the value of individual results. In the pottery described in the previous chapter a great many different clays were used and each one proved suggestive to the potter. In porcelain, on the other hand, the body clay is almost identical wherever prepared, the requirement of a white translucent paste being paramount.

CHAPTER IV

The Nature and Properties of Clay

CLAY differs from earth or soil in that it possesses certain characteristics which these do not possess. Its distribution is very wide but for the most part it lies concealed from view. In certain parts of the country it is so abundant that it breaks through the surface or is exposed as an outcrop but usually it is covered by the soil which supports vegetation. Unless the subsoil consists of sand it is easy to expose a clay by plowing or digging with a spade. It usually appears as a greenish or bluish substance of close and uniform structure. The texture is sometimes smooth but more often numerous small stones are found imbedded in the mass. Such clays as are commonly found can be used for the manufacture of some kind of pottery but in the great majority of cases the ware will be red when fired because the clay contains a proportion of oxide of iron. A pure clay does not contain this and therefore becomes white or nearly white in the kiln.

Pure clay, known as clay base or clay substance forms a part of all natural clays though sometimes

only a small part. It consists of silica, alumina and water in a state of combination and is thus known as a hydrous aluminium silicate. While this substance is very common as an ingredient of ordinary clay, it is rarely found alone or uncontaminated. Commercial or workable clays may be said to consist of clay base and sand, with or without other impurities such as lime and oxide of iron. For working purposes it may be granted that the potter has to deal with a mixture of clay and sand. But sand is not a definite expression. It may vary both physically and chemically within wide limits. The physical nature has to do with condition, the chemical with composition. Thus a sand may be almost as coarse as gravel or as fine as the clay itself. It may be a pure quartz sand or it may be a crushed rock of almost any composition. The former is known as quartz, the latter as feldspar or feldspathic sand because it approaches in composition the group of minerals known as feldspars. Each of these ingredients, clay, quartz and feldspar, has an important part to play in the transformation of clay into pottery. Few of the clays used in making white pottery possess these ingredients in the correct proportions so that it becomes necessary to make a mixture in which the necessary proportions will be found.

For successful pottery making three properties are

demanded in a clay. First, plasticity. Without this, clay could not be shaped at all. It constitutes the obedience of a clay to the forming influence whether hand or mold. The necessity for this quality may be illustrated by the proverb "Making ropes of sand" as an example of the impossible. Sand, possessing no plasticity, cannot be shaped or made to hold together.

The second property is porosity. A clay which exhibits a high degree of plasticity can be easily shaped but it cannot be safely dried. The water of plasticity cannot escape and therefore the clay warps and cracks. The function of porosity is to prevent this. A porous clay permits the water to escape freely and the clay can be dried without damage. This condition is produced by the admixture of sand or by the presence of sand in a natural clay. A coarse sand is more effective than a fine sand but a sand that is too coarse will interfere with delicate working while a sand that is too fine approximates the action of the clay itself and produces a substance which is dense rather than porous. Porosity is therefore the reverse of plasticity and these two properties must be adjusted so as to balance each other.

The third necessary property is commonly known as vitrification but could be better named "densification" because complete vitrification is not attained in ordinary clay wares. This property may be defined as that which causes a clay to yield to the action of

a high temperature so that the result is a ware, more or less dense, which is hard, durable and sonorous. With this there must be coupled a certain amount of resistance to heat treatment so that the pottery does not fuse or collapse during the firing. Here also is found the need for adjustment. The clay must yield to the fire but not completely. It must resist but not entirely.

Plasticity is due to the clay base. Not only to its quantity but to its quality also. Some forms of clay in which clay base predominates are not plastic because the clay base itself is coarse grained. Other forms with less clay base present are plastic because this ingredient is fine grained and tough. Pure clay base is also highly resistant to fire and therefore contributes to the refractoriness of the mass.

Porosity is caused by the sand in the clay. Any kind of sand will produce porosity but the effect differs with the condition of the sand. Coarse sand is more effective than fine sand. More sand will, of course, cause greater porosity.

Vitrification or densification is due to the feldspar or fusible sand. This also varies with the condition. A fine-grained feldspar will produce vitrification more easily than the same amount of coarse feldspar.

Certain substances are available for use in pottery mixtures, which possess one or other of the necessary

properties in high degree so that they will impart these properties to a mass to which they are added.

Kaolin or china clay is usually fine, white, and refractory. Some kaolins are rather plastic but most of them are "short" in working and rather tender. For the production of a white ware kaolin is indispensable. No other ingredient will afford the pure white color which is sought after in porcelain and china.

Ball clay is very plastic, easily vitrified, but is not white. The color varies from a cream to a gray. The use of a ball clay is therefore limited in white wares because it will spoil the color. For wares in which a light cream color is not objectionable ball clays are valuable and almost indispensable.

Stoneware clay is usually a rather plastic clay which contains a good deal of sand, hence stoneware clays can be used for certain classes of ware without admixture. A rather high temperature is required for most of these clays, though occasionally one can be found which will become dense at the fire of a studio kiln. The clays sold by the Enfield Pottery Company and by the Western Stoneware Company are of this type.

Ground flint is a necessary ingredient in almost all pottery. It aids in the porosity of the clay and enables the mixture to be adjusted to fit a special glaze.

Ground feldspar is also necessary. Like flint it aids in the porosity of the unburned clay but unlike flint it produces density in the firing.

By a proper adjustment of these ingredients a clay can be composed which will meet the special requirements of the worker.

In order to ascertain the properties of any given clay certain simple tests may be made and every clay-worker should know how to do this because one cannot be too well informed as to the materials to be used.

First, water of plasticity. A certain portion of the clay, dried and powdered, is weighed out. It is convenient to weigh in grams and to measure in cubic centimeters because in this way calculation is easy. The scales and weights are described in the chapter on glazes. For measuring the water a glass vessel called a graduate is used. One holding a hundred cubic centimeters and graduated in centimeters and tenths can be obtained from a dealer in chemical supplies. One hundred grams of clay is weighed out and transferred to a glass slab. The graduate is filled with water to the one hundred mark. Some of this water is then poured on to the clay, adding little by little as needed until the whole can be worked into a stiff mass of the proper plasticity. The quantity of water used is then carefully noted by observing how much is left in the graduate. Suppose, for in-

stance, 70 cubic centimeters are found remaining, the hundred grams of clay has absorbed thirty c.c. of water and as one c.c. of water weighs one gram the clay has taken just 30 per cent. This amount is important because it is one of the best indications of plasticity. A very plastic clay may need 40 per cent, a non-plastic clay may be satisfied with 25 per cent.

Second, shrinkage. The mass of plastic clay is now transferred to a plaster bat and rolled or pressed out into a smooth slab about 12 centimeters long. Here again the centimeter is used in preference to the inch as being more easily calculated. A faint line is ruled on the clay slab and two fine scratches are marked exactly ten centimeters apart. The edges are trimmed and the excess clay made up into three or four small pieces which are to be fired in different parts of the kiln as tests for density. When the clay slab is dry the distance between the marks is measured and noted. The ten centimeters being divided into one hundred millimeters, each millimeter of shrinkage means one per cent. After firing, a second measurement is made and the differences are noted as dry shrinkage and fire shrinkage respectively.

Third, firing. The slab with the measurement upon it is set in the kiln in the place where the clay wares are to receive the first or biscuit fire and the small pieces are arranged in different places so as to secure

as many different conditions as possible. The position of each should be carefully recorded. After firing, the marks on the slab are measured as already described and note is taken of any warping of the piece. The color is also recorded. The small pieces should be tested for porosity or absorption of water but this is rather a delicate operation and needs a particularly sensitive balance. Generally it will suffice to use a wet sponge or to dip each piece into water, removing it quickly and noting carefully the rate of speed at which the water is absorbed. If the water should be scarcely absorbed at all a line of ink may be drawn upon the pottery with a pen, the piece being perfectly dry. In a fully vitrified ware the ink can be washed off, leaving scarcely a mark but the test is quite sensitive and with a little practice will afford an excellent means of comparing the density of different clays or of the same clay at different temperatures.

Fourth, glazing. It is well to have ready a small supply of a standard clear glaze. Each of the test pieces should be covered with this in a rather thin coat and then they should all be fired again, this time close together so that they will receive the same heat treatment. This will enable one to determine what degree of fire for the clay will best suit the glaze.

CHAPTER V

The Preparation of the Clay

A CLAY having been selected in accordance with the tests described, it becomes necessary to prepare it for use. A fairly large supply should be obtained and stored in a dry place. Most natural clays need some kind of cleansing for there are almost always foreign substances present. This cleansing is accomplished by reducing the clay to the fluid known as slip. The necessary appliances for making slip are as follows:

A large sieve of quarter-inch mesh.

A small wire sieve of about 14 meshes to the inch.

A large barrel.

Two galvanized pails.

The clay is, after drying, powdered and sifted through the large sieve. One of the pails is half filled with clean water and the clay, handful by handful, is sprinkled into it. The clay rapidly absorbs the water and sinks to the bottom. The addition of clay is continued until a small mound rises through the water, when the whole is left to soak for an hour. The bared arm is then plunged into the pail and the

mass stirred vigorously. A stick or paddle will serve, of course, but the potter learns a great deal by the feel of the clay and therefore the hand is best. It is said that he is a poor sailor who will not dip his hands in the tar bucket and in like manner, he is a poor potter who fears the slip tub. This stirring will tell a good deal about the probable working of the clay. It may be stony or sandy or greasy. The large stones and roots will have been removed by the sieve but now, after thorough mixing, the slip is poured through the small sieve into the barrel. Both pails may be kept going at once, one being filled while the other is soaking and so on until the barrel is full or, at least, a good quantity of slip has been prepared.

If the clay prove very sandy it should be washed. The mixture in the pail having been well stirred is allowed to stand for a definite time, say one minute. The slip is then poured into the second pail and it will be found that a quantity of sand has settled. This is thrown away and the slip in the second pail is examined. If enough sand has been removed, the slip may be poured into the barrel, using the fine sieve as already described. If still sandy the process should be repeated, the settling being for two minutes. Experience is the best guide in this operation but all the sand should not be removed.

When the barrel is full of slip it is allowed to stand

over night when some inches of clear water will be found at the top. This is removed with a siphon which may be made of a piece of lead or rubber pipe. The removal of the water results in the thickening of the slip and the contents of the barrel should be thoroughly stirred with a long wooden paddle to insure a uniform consistency. If the slip is found to be still thin another settling and removal of the water will thicken it.

The slip thus prepared will keep indefinitely, provided that it is not allowed to become dry by evaporation. It improves greatly with age. This is the material which is used for casting as will be described later but for plastic work it must be still further thickened. A shallow box may be procured and made water-tight and the slip, when poured into it, will thicken much more rapidly than in the barrel, but it is better to have some shallow plaster dishes as the plaster itself absorbs the water and thickens the clay. Instructions for making these dishes appear in the chapter on plaster.

These directions will suffice for the preparation of a natural clay but it is sometimes desired to prepare a white body either of earthenware or porcelain. These bodies do not exist in nature and therefore a mixture must be made. The ingredients are kaolin or

white porcelain clay, ball clay or plastic potters' clay, ground quartz or flint, and ground feldspar.*

A suitable mixture for earthenware is—

† Georgia Clay	20	parts by weight
Tennessee Ball Clay	30	" " "
Flint	35	" " "
Feldspar	15	" " "
	100	

and for porcelain—

Georgia Clay	45	parts by weight
Flint	35	" " "
Feldspar	20	" " "
	100	

The earthenware will be creamy in color and porous at an ordinary fire. The porcelain will need a hard fire and will be white and translucent. It is, however, non-plastic and hard to work. The preparation of these mixtures of course necessitates a pair of scales but otherwise the treatment of the mix is the same as that of natural clay. Washing is not necessary but the clay must be powdered, mixed with the flint and

* Georgia Kaolin and Tennessee Ball Clay may be procured from the John H. Sant and Sons Company, East Liverpool, Ohio, and flint and feldspar from the Golding Sons' Company, Trenton, N. J., or the Eureka Flint and Spar Company, Trenton, N. J., in quantities of not less than one barrel or sack.

† If English china clay can be procured it will make a whiter ware than Georgia clay.

spar, and sprinkled into water as already described. In place of the wire sieve, however, a silk lawn of 120 meshes to the inch should be used.

The lawn is simply a fine sieve and is named because of the material (also called bolting cloth), with which it is covered. Have a carpenter make a box without a bottom. Cypress or oak should be used and this should be a full half inch thick. Four strips of the same thickness are also to be provided. The box may be of any convenient size; eight inches square and four inches deep is about right. The sides should be fastened together with brass screws to avoid rust and a piece of lawn is strained tightly across the bottom and secured with copper or brass tacks. A strip of coarse muslin folded and laid along the edges will help to prevent the lawn from tearing, the tacks being, of course, driven through both muslin and lawn. Then the four wooden strips are set upon the muslin and secured with brass screws. The completed lawn is then a tray of which the bottom is formed of lawn. The strips of wood beneath serve to protect the lawn when placed on a table as well as to assist in holding it firmly.*

For storing clay in the plastic state there is nothing better than stoneware jars. These may be had of any

* Silk lawn of any desired mesh may be purchased by the yard from A. Sartorius & Company, 57 Murray Street, New York City; or brass sieves ready for use from the W. S. Tyler Company, Cleveland, O.

size and a tinman should make close-fitting covers. Earthenware covers do not fit tight and are always getting broken. A little water is poured into each jar and a support provided for the clay so that it does not rest in contact with the water. Under any conditions clay will slowly harden so that not too large a stock should be kept. Slip, on the other hand, keeps well so long as some water is always on the top and it is not a long process to stiffen it into clay.

CHAPTER VI

Mold-making and Plaster

PLASTER is almost a necessity to the potter and therefore something should be learned about it. Even if one does not use molds there are numberless purposes for which plaster is convenient. For stiffening slip into clay, and for absorbing water from glazes, shallow dishes of plaster are used, and for holding work either in making or drying, plaster bats or round slabs are always in demand.

It is best to purchase the finest quality of potters' plaster by the barrel.* It will keep indefinitely if stored in a dry place. The necessary appliances are:

One or two large jugs for mixing, or a metal can with a spout.

A metal spider or frying pan.

Six feet of rubber machine belting, six inches wide, or similar strips cut from linoleum or enameled cloth.

Two or three thin pieces of steel of various degrees of flexibility (scrapers).

Handy knives, called vegetable knives.

A small painter's brush.

* Calvin Tomkins, 30 Church Street, New York City.

Two or three fine sponges.

To begin with, a size of soft soap and water is prepared. Put a quart of water into a kettle and add a piece of soap the size of an egg.* Simmer for an hour or until the soap is entirely dissolved and then set aside to cool. When cold the size should be of the consistency of maple syrup. This size is used whenever plaster is to be kept from sticking to a form or surface, and it has also the merit of causing clay to stick to plaster. For example, if a mold is to be taken from a clay model no size should be used, but if a plaster form is used as a foundation for clay ornament it should be well sized first. The size is laid on with a brush and wiped off with a sponge. Another sponge is then used with clean water and the sized surface is washed, all superfluous water being removed. Size is then applied a second time and washed off as before. A third application is sometimes necessary, or until the sized surface rejects water like grease does. On the last sizing, water is not applied, but the surface is polished with the sponge containing size. If the surface to be prepared be of wood or metal a single coat of size will often suffice, but if it be of plaster three or four applications are often necessary.

The first lesson may well be the manufacture of a plaster bat. The frying pan is first sized and set upon a level table. Let us suppose that a quart of

* Any good laundry soap will serve, but it should be sliced thin.

water will fill it to about an inch in depth. This amount of water is put into a jug and two pounds and three-quarters of dry plaster is weighed out and allowed to trickle through the fingers into the water. This proportion has been found to be best for ordinary mixings. A smaller quantity of plaster to the quart of water will result in a very soft bat; a larger quantity will be proportionately harder. After the plaster has soaked up all the water it will take, that is in about two minutes' time, the hand is plunged in and the whole stirred to a smooth cream. All lumps must be broken up and the air bubbles removed as far as possible. Continue stirring gently and presently the mixture will be felt to grow thicker. The psychological moment arrives when the plaster forms upon the hand a white coating which cannot be shaken off. The creamy liquid is then poured into the frying pan which is gently shaken to level the surface.

If the plaster has been poured at the right moment it will set smoothly with a mat surface like sugar icing. If poured too late it will be stiff and difficult to level, and if poured too soon it will curdle on the surface and water will be seen above the plaster. A little practice will show the right moment. The jug should be washed out immediately while the plaster is soft. In the place used for plaster work a tub should be provided in which all vessels and tools can

be washed, for, if allowed to flow down the waste pipe of a sink, the plaster will speedily choke the outflow.

After standing for some ten minutes, more or less, the bat in the frying pan will grow warm. This is the sign of a combination between the plaster and the water and shows the completion of the setting. The pan is now taken by the handle and, holding it upside down, the edge is rapped smartly on a brick or stone. This will cause the contents to fall out and there is

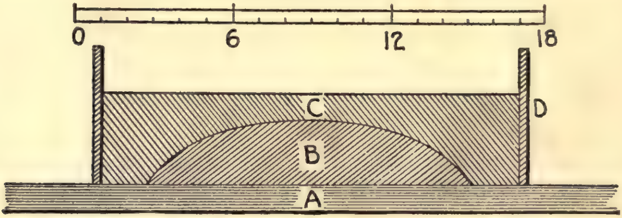

FIG. 1. *A*, table. *B*, clay mound. *C*, plaster. *D*, rubber belt.

a smooth disc which is one of the most useful of appliances. The edge will need to be scraped and the bat can be set aside until needed. It will be good practice to make a half dozen of these.

This process of mixing and pouring plaster is the same for all operations and the instructions will not be repeated, but when the student is told to "pour plaster" it will be presumed that this experiment has already been made.

The next step is the making of a plaster bowl or dish for the purpose of drying out slip or glaze. A convenient size should be determined upon as it is best to have all the dishes the same. Upon any flat, smooth surface a mound of clay is reared which shall be the size and depth of the inside of the proposed dish. About twelve inches in diameter and three inches deep is a good size, though fourteen inches is not too large for the former dimension. This mound should be made as nearly circular as possible and the clay finished as smoothly as may be. The rubber belt is then set around the mound in the form of a hoop leaving a space of two inches between the clay mound and the rubber hoop. The rubber is fastened either by tying with string or by binding the overlapping ends with clothes pins. A roll of soft clay is laid down where the belt joins the table and pressed down outside to prevent leakage. Enough plaster to fill the space within the belt is now mixed and poured, covering the clay mound to a depth of at least one inch. When the plaster has set the rubber is detached, the whole turned over and the clay dug out. We have now a circular plaster dish three inches deep but we have only one. The trouble of rebuilding the clay is unnecessary a second time because a "case" or reverse can be made from which as many dishes as may be necessary can be formed.

The dish is carefully smoothed and trimmed. The sharp edge is removed and the inside is dressed with fine sandpaper to a perfectly smooth surface. Size is now applied to the inside and upper edge until a bright slippery surface is obtained. The rubber belt is now

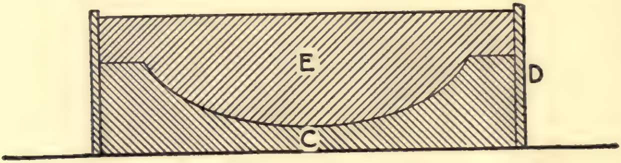

FIG. 2. *C,* plaster dish. *D,* rubber belt. *E,* plaster case or reverse.

bound closely around the dish and plaster is poured to a depth of about one and one-half inches on the edge. This, of course, makes a depth of four and one-half inches in the center. When this new plaster

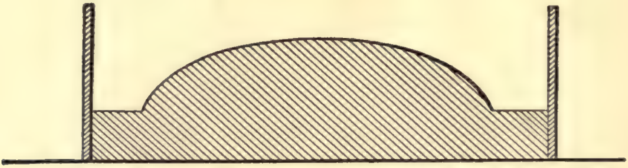

FIG. 3. Plaster case, with rubber belt, arranged for pouring.

has set in turn the rubber is removed and the two castings can be easily separated by inserting a knife at the junction. The knife should be gently driven in with a hammer. Obviously it is now possible to

make a number of dishes from the reverse thus obtained, by simply binding the rubber belt around each time and pouring plaster as at first. The original mold having been sized is no longer absorbent but must be kept in case additional reverses are needed. The molds or dishes must be thoroughly dried out before being used.

The molding of a vase form is more elaborate but not really difficult. Even if one does not intend to produce pottery by molding there is always an advantage in having a number of simple forms upon which to make experiments.

The vase to be molded is first drawn to exact size upon paper and a plaster model is turned on a lathe. This can be done equally well on the potters' wheel and the method is as follows: A plaster bat is saturated with water and set upon the wheel so as to run true when the wheel is revolved, and is cemented to the wheel head by a little slip. A few deep scratches are made on the face of the bat and a cylinder, either of the rubber belt or of stiff paper, is rolled up and set on end in the center of the bat. The size of the cylinder should be a little larger every way than the proposed vase. Plaster is now mixed and poured to fill the cylinder. It will adhere to the bat below by reason of the scratches. When the plaster has set, the cylinder is unfastened and removed and the turning may begin. To turn plaster well in-

volves a good deal of practice but it is better to spoil three or four plaster cores in the learning than to spend a long time on one for fear of damaging it.

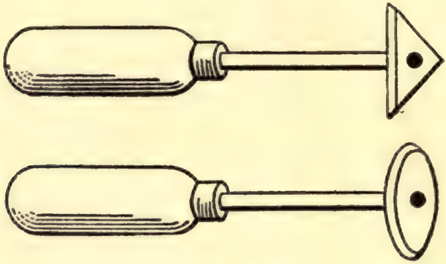

FIG. 4. Turning tools for plaster.

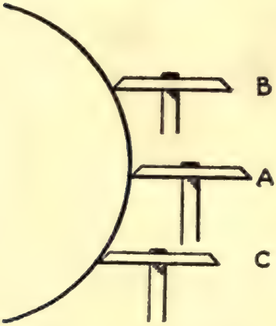

FIG. 5. Position of tool in turning.
A, correct. *B* and *C*, incorrect.

The board support and turning stick described on page 100 are used in turning plaster as well as clay.

The turning stick is held in the left hand and the point is pressed into the board. All this is, of course, made ready before the plaster is poured. The turning tools are here illustrated. They are not sold in the stores but can be made by any machinist. The head or cutting blade consists of a flat piece of steel through the center of which is a shaft or pin which is driven into a handle. The head may be of any shape but the triangle and the circle will meet every need. The tool is held in right hand and braced against the turning stick, the stick and tool being moved together by raising or lowering the left hand which holds the butt of the stick.

While the plaster is still soft the round tool is used and the rough form is rapidly turned. Then as the setting of the plaster proceeds and it is found to grow harder, the triangle tool should be used and the shape gradually wrought out with the point. Finally by using the circle tool for concave lines and an edge of the triangle tool for convex lines the form is perfected. The surface is to be finished and the tool marks removed by using, free hand, a flexible scraper which is bent by the fingers and thumb to fit the lines of the form, and a final smoothing is given by fine sandpaper, the wheel being revolved all the time. At the top of the form a small cylindrical piece is left, called the "spare" which represents the thickness of the mold substance, and for the bottom a small piece is

turned in the shape of a truncated cone. The small end of this should be the same diameter as the base of the vase. These are shown in the illustration (Fig. 6).

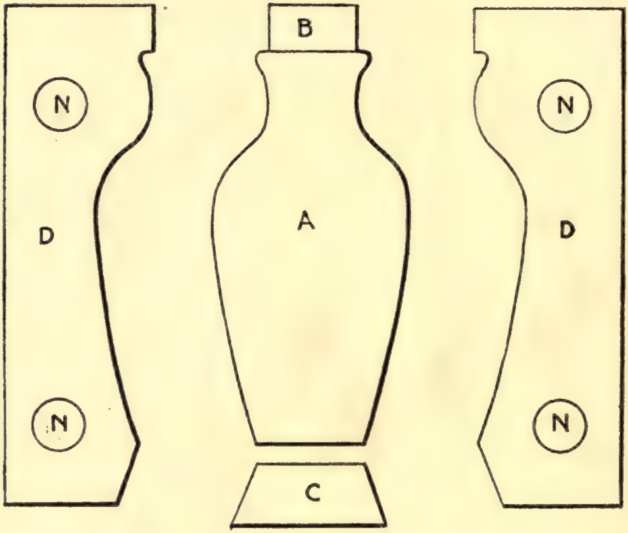

FIG. 6. Vase with foot piece and template. *A*, vase. *B*, spare. *C*, foot piece. *D D*, templates. *N N N N*, natches.

It will be obvious that in the directions given above the base of the vase is not finished off and therefore the form must be cut off from the bat, either by a knife or saw, and the base is then finished by hand, or by setting the form upside down in a clay cradle—

called a "chum"—and turning the base true. The form is now ready for molding.

The plaster vase is laid upon its side on a piece of soft clay and a thin bat or plaster slab is cut to fit

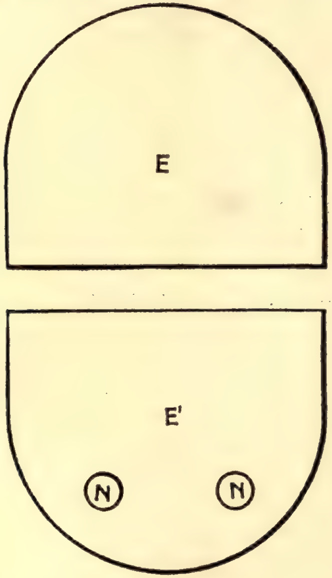

FIG. 7. End plates for mold.
E, upper plate.
E', lower plate.
N N, natches.

the outline. This template should fit with reasonable accuracy but need not be absolutely exact. A pair of

these will be required, one to fit each side of the form. These slabs or sheets of plaster are always useful and if a sheet of glass is kept handy any excess of plaster left from a mixing may be poured on to it. This upon setting is easily detached and will present a smooth face where it has rested on the glass. The pair of templates must include, in their outline, both the spare and the foot piece but should not extend beyond either of these. The outside diameter of the mold is now to be determined and the templates cut to this dimension so that the two together, with the vase between them, constitute a longitudinal section of the mold.

The vase must now be divided accurately into two halves by a line running from top to bottom. There are several ways of doing this. While the form is still on the bat a diameter of the bat may be drawn and a perpendicular erected from each end of this diameter. These perpendicular lines will, of course, mark the center of the vase on each side; or after the vase has been cut off another method is possible. With a pair of dividers find the center of both the top and the bottom of the vase. Mark each with a small hole or the point of a pencil. Now lay the vase on its side on the clay cradle upon a glass sheet or other level surface and raise or depress one end until the two centers are exactly the same height from the glass. Take this height in the dividers and, sliding

one of the compass legs along the glass, gently scratch the plaster vase with the other or upper point. If the two centers have been accurately adjusted this scratch line will be the exact center of the form.

Some soft clay is now built up on each side of the vase and the templates are pressed down upon it, one on each side until the upper face of each corresponds with the scratched line. The vase is now seen to be buried as to one half in a plaster surface, and plaster poured on this will give a half mold. There is yet, however, nothing to confine the plaster and it would flow away as fast as poured. Two end plates are necessary and these must rise in a half circle above the bed formed by the templates. The part below may be of any shape but must be high enough to cause the diameter of the half circle to coincide with the plane of the templates. Two pieces of cardboard, wood, or rubber belt are now bound to the sides, the apertures at the top and bottom, caused by the curve of the end plates, are stopped with clay and the whole presents the appearance of a vase, only half of which is visible, lying in a shallow trough. All the fitting should be carefully done but the tying up is not yet. The whole is now taken apart and well sized. Vase, foot piece, templates and end pieces are all to be sized thoroughly in the manner described. They are then put together again and bound around with twine. It is necessary now to make provision for the

proper fitting of the halves of the mold. This is done by providing knobs and hollows which fit together. These are technically known as "natches" and will be referred to as such. Take two pieces of moderately stiff clay each about the size of a cherry. Roll them into neat balls and cut them in two with a thin knife. Lay each of the halves, flat side down, upon the templates, two on each, placing them in pairs opposite to each other. Affix two or more of these on the inner face of the bottom end plate. Now mix and pour the plaster. This should be poured to the height of the top of the end plates and, after pouring, shake this well down by dipping the fingers into it, so that no bubbles may cling to the surfaces below. As soon as the plaster has become firm but while it is still soft remove the string and the side boards, pull off the pieces of clay and with a straight, thin piece of wood scrape off the surplus of plaster by following the line of the end plates and thus making a half cylinder.

As soon as the plaster has become warm the whole may be turned over and the templates and end plates removed. The four half spheres of clay will be found embedded in the face of the plaster and these, being removed, will leave four hemispherical depressions. The vase can now be gently detached from its bed and the first half of the mold is completed. A little dressing will be necessary. All overhanging edges

and rough places should be finished off and the hollow natches smoothed with a piece of muslin on the end of a finger.

The second half is simple. Replace the vase in the half mold, set the foot piece in its place, replace the end plates with the diameter on the line as before but with the semi-circular edges upward, and set two or three clay natches on the bottom one. Size, bind up, pour and scrape off as before, thus completing the two halves of the mold in cylindrical form. It only now remains to make the bottom for, at present, the mold is open at both ends.

The two halves with the vase inside are bound very tightly together with twine and set on the table bottom upwards. The clay natches in the bottom are taken out and the hollows smoothed. The foot piece is taken out and the rough places dressed. The bottom end of the vase is now visible and this, together with the end of the mold, is sized. A strip of stout paper is bound around the mold, projecting about an inch above the end and plaster is poured to fill it. When this is set the paper is peeled off and the edges of the mold are dressed smooth. The bottom may now be detached by inserting a thin knife at the junction, the mold opened and the form taken out. The mold is now in three parts which may be put together at will and used for casting the vase in clay.

CHAPTER VII

Cases and Working Molds

THE mold described in the previous chapter is called, technically, a "block mold" and is not, as a rule, used for making the clay ware. The reason for this is that molds will wear out more or less rapidly and to repeat the process of making new ones from the original form would be tedious and expensive.

From the block mold a reverse is made, called a "case," and from this, in turn, working molds are made in any required number. While it is possible to use the block mold as a working mold, and, if only a few pieces are required this is quite sufficient, yet, as it is often necessary to have a number of molds, the student should understand how to make a case.

A case may be defined as a mold from which a mold is made. If one can imagine the visible half of the vase form as it appears in making the mold, with the templates and ends cemented into one piece, one has a conception of one half of a case. The problem is to make this with permanent but movable ends so as to have a convenient form from which half molds may be easily made.

The ends are joined to the body by means of offsets and the first step is the construction of these. One half of the block is taken and laid upon its

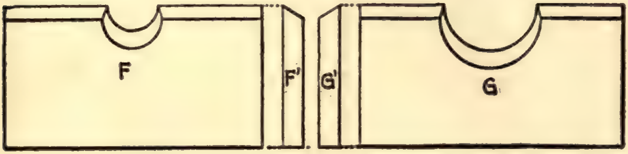

FIG. 8. Offset plates. *F*, top plate, front view. *F'*, side view. *G G'*, bottom plate.

back, being supported by clay so that the face is level and steady. An offset plate is now cut to fit each

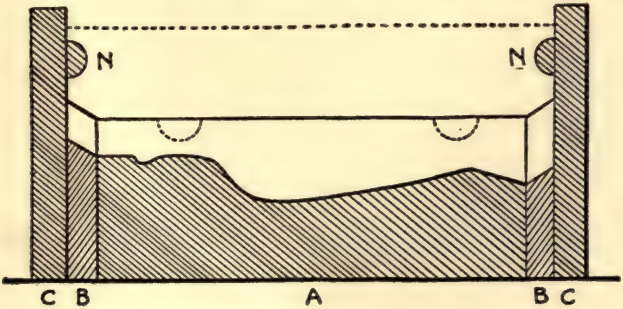

FIG. 9. Sectional view of mold ready for casing. *A*, mold. *B B*, offset plates. *C C*, end plates. *N N*, natches.

end. To make these a piece of plaster is selected or made which is true and smooth on both sides. The

plates are cut of the same width as the mold and are beveled at the upper edge so as to rise slightly from the mold face. The curve at the end of the mold is cut out to fit and beveled in like manner. Then two end plates are fitted. These should be about two inches higher than the offset plates and are square at the top. Upon each of these two or three clay natches are set, being placed low down near the face of the mold. The mold and plates are well sized and bound together with side walls just as in the making of the mold. Plaster is poured to a height sufficient to well cover the natches and left to set hard. No shaping is necessary. When well set the end plates and offset plates are removed but the vase mold and the case are left attached together. The other half of the mold is prepared and run in the same way, the same offset plates and end plates being used with such slight refitting as may be necessary. The work is now examined and all rough places and scraps of adhering plaster are removed. The two halves of the case, the half molds being still attached, are set up on end, back to back, being separated by a thin piece of plaster or a strip of cardboard which should extend two inches above the top. The top ends are now sized, the natch holes having been smoothed off, a band of paper is tied around and plaster poured on top to a depth of about one inch. When set the whole is turned over and the operation is repeated on the

other end. After the final setting the ends are easily removed and by the insertion of a thin knife driven by a light blow, the molds and case are separated.

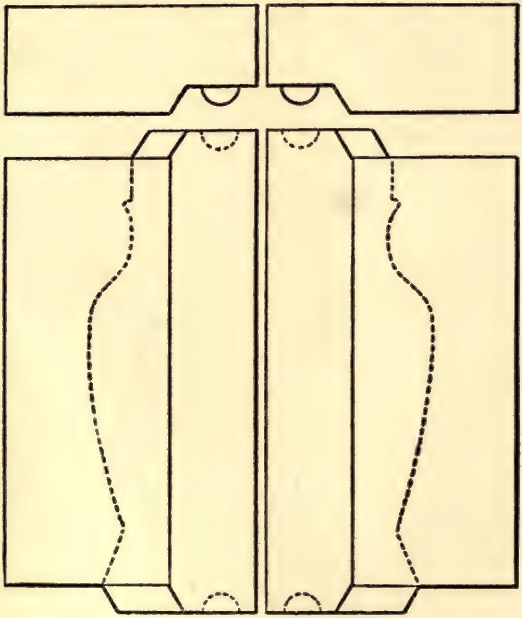

FIG. 10. Mold and case in position. The top ends are lifted to show fitting. The bottom ends are not shown.

Each half case is now laid on its back and the proper ends are fitted in place. It only now needs the usual

side walls to be tied on and molds can be made with ease just as the original block mold was made.

It now remains to make a case of the bottom mold. The bottom piece of the block mold is taken and sized and with a strip of paper bound around it, plaster is poured. The two are detached when set and the case is finished. It consists of seven pieces; three are used in each half and one for the bottom.

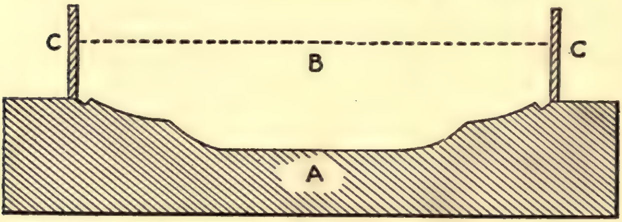

FIG. 11. Block of plaster with face of plate turned. *B*, height of plaster to be poured. *C*, rubber belt.

Thus equipped it is possible to make any number of working molds and if the case should wear out or be damaged, a new one can always be made from the block mold. The block mold itself, having been sized, is no longer absorbent and cannot be used for making vases. The working molds should be thoroughly dried before using and they will last longer.

Flat ware, such as plates and saucers, is made on, not in, a mold. The diameter of the plate having been

decided upon, a block of plaster three inches wider is run. This is placed on the center of the wheel or jigger and in it the face of the plate is turned. This must be sunk below the level of the block and when finished, must appear as though the plate itself were embedded in the plaster. One half of the thickness of the edge is shown in such a way that there is no under cutting. Just outside of this edge the plaster is turned so as to slope gently up to the level of the block.

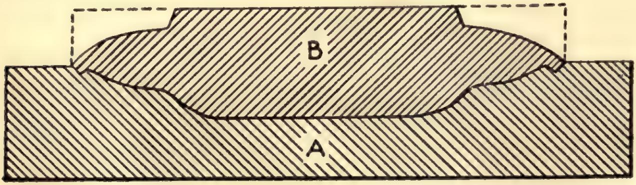

FIG. 12. *A,* block of plaster. *B,* mold poured on face of plate and turned.

Without removing the block from the wheel the face of the plate is well sized, a band of belting is arranged, of the same diameter as the edge of the slope and plaster is poured to a depth of three inches. Out of this the back of the mold is turned as shown in the illustration (Fig. 12).

The top of this as it lies upside down is shaped with a straight, almost upright slope which enables the mold to be set securely in the wheel head. Around

the exposed edge of the original block, three or four natches are now bored or cut. They should be placed at irregular distances so that there will be no doubt as to the putting together of the sides of the case. If two circular pieces of plaster have to be set together and held by natches there should always be either this irregular spacing or some distinctive mark, because if this be not provided for, two or three trials will always be made before the correct fitting is found and these trials wear out the natches very quickly.

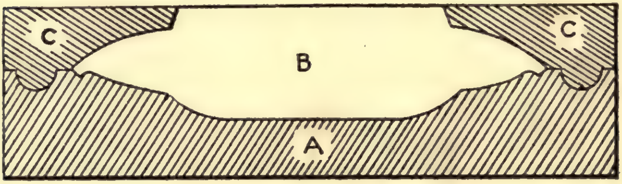

FIG. 13. *A,* bottom of case. *B,* Cavity for pouring molds. *C,* top of case.

The back of the plate mold and the edges of the block are now sized and plaster is run to the level of the highest part of the mold but no higher (Fig. 13). When this is set, the two halves of the case can be separated and the mold taken out. Now when the halves of the case are fitted together there will be a cavity the exact size of the mold. This can be filled again and again with plaster, a new mold being formed each time.

In order to use these molds a special head must be provided for the wheel. The regular head of the wheel should be detachable and in its place an iron frame called a prong is fitted. This consists of a collar either with a hollow cone or a screw to fit the

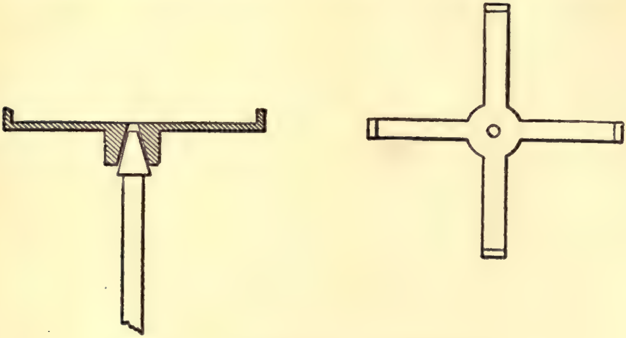

FIG. 14. Iron prong to fit wheel head.

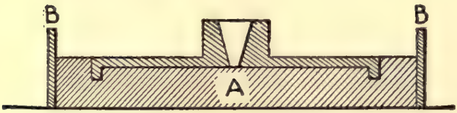

FIG. 15. *A,* plaster, with prong inserted. *B,* rubber belt.

shaft of the wheel, and from this radiate four short arms. In order to use this a circular block of plaster some two or three inches thick is poured on a table or slab and just as this is setting, the prong, upside down, is pressed into it just below the surface and

held there until the plaster is hard enough to support the weight of the iron. When hard, the whole is lifted and the prong with the plaster attached is set in position on the wheel. This now forms a rough plaster head and it must be turned true. In this head a circular depression is to be turned which will exactly fit the back of the plate molds. If the recess should wear larger as it will if much used, a new head can easily be run. The same principle can be applied to the making of molds for saucers.

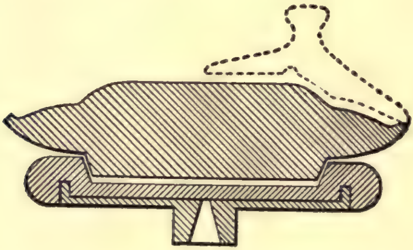

Fig. 16. Wheel head with plate mold. The tool used is shown in dotted outline.

Cups and bowls are molded from the outside. A block of plaster about one inch thicker than the height of the proposed cup is taken and centered upon the wheel. Out of this the piece is to be turned, upside down, leaving a ledge or platform, the outside diameter of which is the size of the mold. The rubber belt

is tied around this and the mold poured. If for casting this will suffice, but if it is intended to make the cups upon the wheel the outside of the mold must be turned to fit a wheel-head which is hollowed to receive it. The making of the cups is described in Chapter XI. A bowl is simply an enlarged cup.

CHAPTER VIII

Building by Hand

THE production of pottery by hand is a form of modeling but with the important difference that while pieces modeled by art-school methods are not intended to be preserved in the clay itself, built pieces are destined for the fire. It is therefore necessary not only that a special clay be used but that the work be such as will hold under the strain of the burn. The composition of the clay has been dealt with in another chapter and it is presumed that the worker has decided upon the proper mix or has procured a suitable clay.

There are two possible treatments of built pottery; the work may be finished by fingers and tools only or it may be placed upon the wheel and turned to a true surface. In the latter case the result is much the same as if the piece were thrown on the wheel as will be described. The principal point of difference is that while building needs less practice than throwing, turning a built piece is much more difficult and tedious than turning a thrown one. It is almost impossible to build with sufficient accuracy for the work to run

true, and a great deal of time is consumed in filling hollows and removing lumps. These do not appear obtrusive when the work is held in the hand, but if it be revolved upon a fixed center every slight irregularity appears to be accentuated. On the other hand the charm of built ware lies in the subtle plastic quality which belongs to no other material or method.

For very large pieces such as tree pots the combination method is useful but these should be built on the wheel itself and kept true as the work proceeds. Then a slight turning at the finish, when the clay is leather hard, will produce a satisfactory result.

The clay for building should be rather soft as it is apt to dry quickly on handling. The work may be done either with coils or pieces.

A plaster bat should be made with a low dome in the center. This bat may either fit the wheel or not, depending upon the plan adopted. The dome is to raise up the bottom of the vase and form a foot. The table may be covered with a piece of oil cloth or may be kept slightly damp. The first attempt should be to build a cylinder as this form is easy to construct and to keep true, so that the attention may be devoted to the manipulation of the clay.

It is first necessary to roll out the clay into cords which should be a little thicker than the proposed walls are to be. These cords should be as uniform as

possible and should be rolled quickly to avoid undue hardening. It is best to roll them as required. The domed bat is made quite damp and upon it should be marked the diameter of the cylinder to be built. A roll of clay is taken, one end laid in the center of the bat and the rest is coiled around it in a spiral line. When the disc so formed has reached the proper size, the coils are gently rubbed over with the fingers until they have thoroughly united and the lines of the spiral have disappeared. The clay disc may now be turned over and the rubbing continued on the other side. The circle is cut true and a new coil is laid on the outer edge thus making a shallow circular tray. In raising the walls it is best to pinch off the roll of clay when one circle has been completed and the new roll should be begun at another point so that all the joints will not be at the same place. This plan is better than coiling a long roll in a spiral for in this case one side of the piece will be higher than the other.

After three rolls have been laid in position the wall, both inside and out, should be worked like the bottom so that the rolls will disappear and the clay be welded uniformly together. This should be done without water or with as little as possible. The use of water is very tempting. It makes the clay so smooth and seems to help but it will inevitably make the work sloppy and will tend to soften the walls.

After three or four rolls have been worked in, the piece should be laid aside for some hours to stiffen. If this be not done the weight of the second building will cause the work to sag and fall out of shape. For this reason it is well to have two or three pieces in hand at once so that there need be no waiting. When the cylinder is of sufficient height it should be allowed to become quite stiff and then the irregularities should be corrected with a little soft clay which is worked into the joints. The whole surface may now be gonc over with tools and brought to the required finish. As soon as the clay is hard enough it should be removed from the damp bat and placed upon a dry one to become dry.

In the method of building by pieces no rolls are prepared but the clay is taken, pinch by pinch, each morsel being pressed into place as the work goes on. This plan is somewhat more plastic in effect and is well adapted to free-hand work; the resulting pottery, however, is generally thicker and heavier.

The craft of building is not mastered until the lines of a drawing can be successfully followed. The clay is apt to choose its own way and the result will be very different from what the potter intended. The design should be carefully worked out on paper, full size if possible, and the clay form should be compared with the drawing as the building goes on. A profile

may be cut in cardboard and this, applied to the clay from time to time, will verify the line, but all such mechanical aids should be used sparingly as the value of this work depends largely upon the sense of freedom and self-expression which belongs to it.

The thickness of the clay walls is a matter of great importance. A small piece should not be so thick as to feel clumsy and heavy, nor should a large piece be so thin as to lose the sense of strength and solidity.

It may be found on drying the ware, that cracks, especially in the bottom, are developed. The cause of this may be in the clay. A clay which is too plastic or too fine in the grain will surely crack. Such a clay may be opened or meagered by the addition of ground flint or fine grog. The cause may, on the other hand, be in the building. If the welding of the coils or pieces be imperfectly done, cracks are sure to result. If the bottom be too thick it will crack. A great strain is put upon the bottom in drying. The clay must be able to shrink and while the side walls are able to settle down on themselves, the bottom is pulled in every direction by the sides. The bottom should be made quite thin in the center and thicker toward the edges. This will help to avoid cracks. A bad crack cannot be successfully mended. It is best to break the piece and begin again. To burn it means the loss of the clay but the clay will be saved if the

damaged work be withheld from the kiln. A small crack on the edge is also hopeless. A crack showing on the edge of a piece is a bad fault. A small crack in the bottom may be mended by dampening the place carefully and pressing in a little stiff clay.

CHAPTER IX

The Potter's Wheel

MUCH of the glamour of the potter's art is associated with the wheel. Poets have sung its praise and artists have delighted in its rhythmic motion, but alas! the wheel as a commercial method of manufacture is doomed to extinction. It cannot compete with the precision and speed of machinery. It devolves, therefore, upon the artist potter to maintain the wheel in its rightful place as, *par excellence,* the potter's tool.

No clay worker's studio should be without a wheel, but the particular form of wheel depends upon the nature of the circumstances under which it is to be employed.

The simplest wheel is that used by the Chinese. A circular plate with a heavy rim is set upon a spindle so that it will revolve freely and run steadily. As the workman sits or kneels upon the floor the surface of the wheel is about at the floor level. Around the periphery and upon the upper surface four holes are sunk and the workman, inserting a short stick into

one of these, gives the wheel a rapid motion. Then while it is revolving by its own momentum the clay is centered and shaped. As the motion is lost the stick is again inserted and the wheel spun. This method, of course, involves much skill on the part of the workman.

In the next form, one which is only adapted, however, for crude experimental work, the wheel is set upon the frame of a sewing machine and operated by the treadle. A beginning may be made upon such a wheel but the operator will soon wish for something better.

A common factory form and one which is well adapted for studio work is the kick wheel. The wheel head is set at the top of a spindle and in the upright shaft there is a crank to which is attached a horizontal moving treadle. This is worked continuously by the left foot, the weight of the body being supported by the right. The action is strenuous and scarcely fitted for persons of other than robust physique but it can be used successfully after practice. This wheel is made by the manufacturers of potter's machinery.

Another form of the kick wheel is used in Europe and is, in fact, the original wheel used by the French and German potters in the seventeenth century. The head is set on a spindle as usual but instead of the crank there is a large heavy disc on the bottom of

the shaft and revolving in a horizontal plane. This is within reach of the foot and the operator, being seated, imparts a rapid motion by pushing, usually with the ball of the right toe. The momentum is kept up by the weight of the disc and there is a great advantage in that the foot need not be in continuous motion. On the other hand it is difficult to acquire sufficient speed and power for the work.

There are several forms of machine wheels which are entirely satisfactory but which need the application of power. If a gas engine or a water motor or electric current be available, every effort should be made to obtain a wheel of this description. The prime motion is imparted to a short horizontal shaft which moves at a constant speed. Then the operator, seated in comfort, regulates the speed of the wheel itself by pressure upon a treadle. No action is required but a simple pressure, light for a slow speed and heavy for rapidity. Where the electric current is available, nothing could be better. Self-contained motor-driven wheels are available but are rather expensive.

One more plan may be mentioned in which the wheel is simply a vertical lathe with a belt and handle to be turned by an assistant. This may be convenient for some but it is not always possible to secure help at the moment when the wheel is to be used. More-

over the cost of labor would soon pay for a mechanical wheel.*

Whatever type of wheel is selected it should be arranged with a head which can be removed. There are two methods of constructing this; the head may be screwed on to the spindle, or the latter may terminate in a cone-shaped plug upon which the wheel head is made to fit as in the illustration (Fig. 14). The latter plan is to be preferred as the head can be removed more quickly and is not so likely to work loose. Several heads for the wheel can then be provided, one for regular work, one for making plates, one for finishing and so forth.

The regular operation performed upon the wheel is termed either throwing or turning according to the industry in which it is employed, but in this description the word "throwing" will be used because the subsequent operation in which tools are employed is best described as turning.

The best head for the wheel to be used in throwing is made of hard wood or brass because the ball of clay can be easily centered upon a smooth surface. This, however, involves that the work shall be cut off with a wire and removed while soft. This is common-

* Information as to the usual types of wheel may be obtained from The Crossley Manufacturing Company, Trenton, N. J.; The Patterson Foundry and Machine Company, East Liverpool, Ohio; a wheel operated like a sewing machine is sold by the Lewis Institute, Chicago.

ly done by professionals but is beyond the skill of the beginner. It is best, therefore, to use a head like that illustrated for plate making and to have a number of specially shaped plaster bats to fit the recess (Fig. 17). Then when the piece is formed, the bat with its burden can be set aside for the work to harden.

Throwing is not an easy operation to describe but the following instructions in the form of lessons will, with a large amount of practice, enable the student to become fairly expert. Every opportunity should be taken to watch a good potter at work. There are a thousand and one little tricks in the position of the

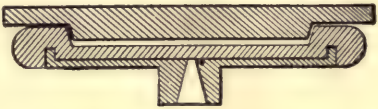

Fig. 17. **Wheel head with detached bat.**

arms, hands, thumbs and fingers which are impossible to describe but which can easily be copied. If a kick wheel be used some time must be given to practicing the motion without using clay. The action of the foot must become subconscious or automatic like the pedaling of a bicycle so that simply to will a change of speed is to accomplish it.

Lesson I. Take the bat about to be used, plunge it in clean water and soak it nearly, but not quite, to

saturation. If the bat remain wet one minute after being taken from the water it has soaked too long and must be dried off a little. The effect of a wet bat is that the clay slips and cannot be held in one place. The proper dampness is secured when the clay ball can be pushed along the surface of the bat but does not slip easily. This condition is important and should be secured by experiment, because if not right, good work will be impossible.

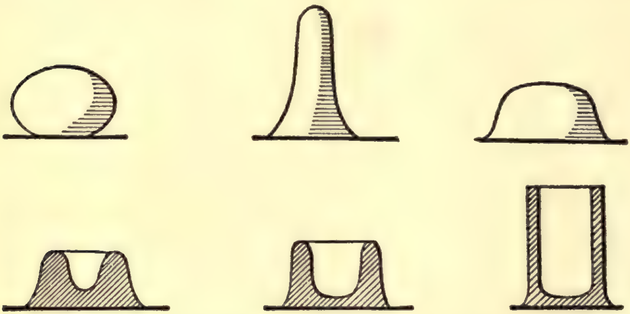

FIG. 18. The progress of a clay ball on the wheel.

Lesson II. Place a small basin of water close at hand. Take a ball of clay about three inches in diameter. Set it on the center of the wheel as nearly as can be judged. Now spin the wheel at a fairly rapid rate. Brace the left elbow against the side and, wetting the hand, press the ball of the thumb and the lower part of the palm against the clay. The left

PLATE I. THROWING.—LESSON II, I.

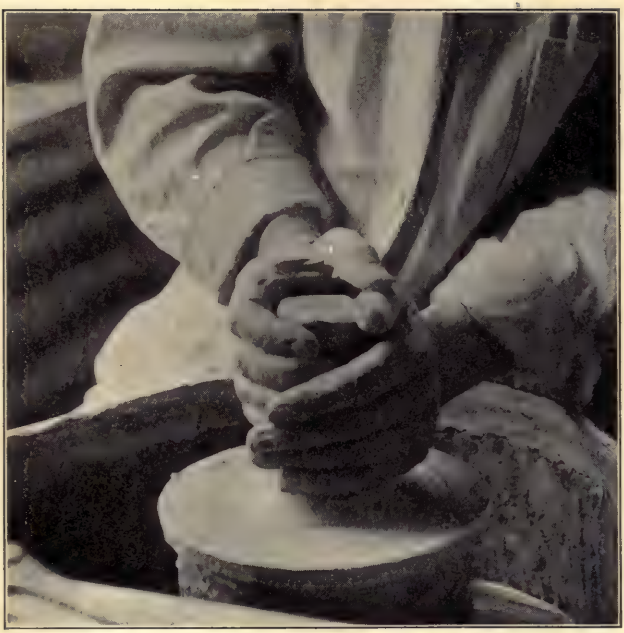

PLATE II. THROWING.—LESSON II, 2.

PLATE III. Throwing.—Lesson II, 3.

PLATE IV. Throwing.—Lesson III, 1.

forearm being kept rigid, the clay as it revolves will be forced into the center of the wheel. Use the right hand to sprinkle water on the clay that proper lubrication may be maintained. With the fingers of the right hand pull the clay towards you, at the same time pressing inward with left hand and so squeezing the clay. As the hands come together the clay will rise in a cone. Do not pull it upwards but let it rise as it is squeezed. Now bring the hands over the top and with the thumbs together press down again. Lumps and irregularities will be felt in the clay and the operations of spinning up and pressing down must be continued until these disappear. Repeat the exercise of centering with a fresh ball of clay until it can be accomplished with ease and rapidity. The clay so used is not wasted. The superfluous water may be dried off upon a plaster bat and the clay wedged up for use again.

This wedging or waging of clay—the word has descended from the old English potters—is important. A strong table should be built of which the top, measuring about 30 by 20 inches, is made of two-inch plank. A raised edge two inches high is fastened firmly by being nailed to the sides; the trough thus formed is then filled with plaster and allowed to harden. An upright post is fastened in the center of one side and from the top of this a fine brass wire

is stretched to the other side of the table, thus making a diagonal. The worker stands at the side of the table opposite the post. The ball of clay is taken in both hands and cut in two against the wire, then the pieces are slapped smartly upon the plaster, one on top of the other. The whole lump is then lifted, cut in two and slapped down as before. The lump of clay is thus formed into layers, the irregularities in hardness are corrected and the clay made smooth. A little practice will make the work quite easy but it will often be found necessary to cut and beat the clay fifteen or twenty times before a good texture is secured. If the plaster table be dry the clay will be stiffened rapidly but the plaster may be made wet to prevent this if it should not be necessary. A clay may also be softened in this way by sprinkling it with water as the wedging goes on.

Lesson III. Center the ball as in Lesson II and moisten both hands and the clay. Grasping the clay lightly but with sufficient force, press the right thumb downwards and towards the palm and a cup-shaped hollow is formed in the clay. Raise the right hand slowly, still keeping a light pressure upon the clay with the thumb. The clay wall will rise with the hand. Now insert the two first fingers of the left hand into the hollow and hold them against the right-hand wall. Slacken the speed of the wheel a little. Bend the forefinger of the right hand and press the

PLATE V. Throwing.—Lesson III, 2.

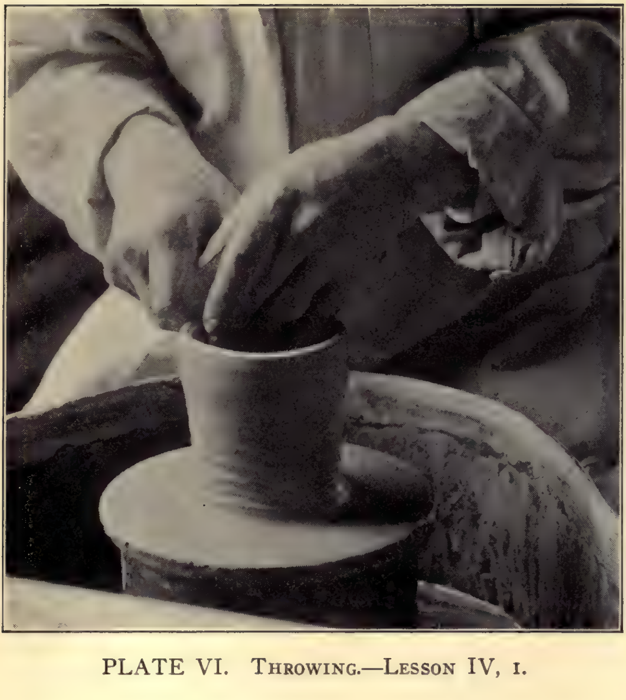

PLATE VI. Throwing.—Lesson IV, 1.

second joint and the knuckle against the outer wall so as to oppose the fingers which are inside. Press the thumbs together to steady the hands and raise both hands upwards together. The fingers inside and outside the clay should be kept at a definite distance apart so that as the hands rise, the clay is brought to a uniform thickness. The hands are brought steadily to the full height to which the clay will go and thus a cylinder is formed.

Repeat this lesson three or four times with fresh clay.

Lesson IV. Keep the hands wet. Shape the clay cylinder as directed in the previous exercise. Now repeat the action of the fingers inside and outside and, beginning at the bottom, take a closer grip of the clay and draw up the walls as before. The cylinder is now taller and the walls thinner. Do this again and again taking a little closer grip each time until the cylinder is as tall and as thin as the clay will bear. The walls will probably spread as the work proceeds and the hands must then be used outside. Grasp the clay with both hands and squeeze it slightly; at the same time raise the hands upwards. This will reduce the diameter of the cylinder and thicken the walls. The operation of the fingers can then be repeated until the full height is reached. There is, of course, a limit to the height of the cylinder which can be made from a given lump of clay and it is best

PLATE VII. THROWING.—LESSON IV, 2.

PLATE VIII. Throwing.—Lesson V.

to begin on a small scale. A ball of clay which can be easily grasped with the hands is the proper size with which to learn. A very small ball is nearly as hard to work as a large one. Repeat this lesson until a tall cylinder can be made with ease and certainty.

Lesson V. Keep the hands wet. Spin up a cylinder with thick walls as in Lesson III. With the fingers of the one hand inside and those of the other hand outside, open the cylinder gradually. Keep the wheel at a slow speed. If the edge runs unevenly, use both hands outside to steady it, then work outwards again until a shallow bowl is formed.

Lesson VI. Keep the hands wet. Spin up a cylinder of medium height as in Lesson IV. With the fingers of the right hand outside press inwards at the base of the cylinder close to the bat and with the fingers of the left hand inside, press outwards at a slightly higher level. This will reduce the diameter at the bottom and increase it in the middle, making a cup shape. Now raise the right hand and gently draw the top inwards. With the left hand inside press the upper edge outward and with the fingers of the right hand shape the upper part into the form of a jar or flower pot.

Lesson VII. Keep the hands wet; proceed as in Lesson VI. Instead of making the top flange outwards, draw it gradually inwards into a globe form. Work the clay carefully upwards and inwards until

PLATE IX. Throwing.—Lesson VI, 1.

PLATE X. THROWING.—LESSON VI, 2.

the opening at the top is almost closed. Several attempts will probably have to be made before this result can be secured.

Lesson VIII. Keep the hands wet. Spin up a globe shape with a narrow base as in Lesson VI but carry a good share of the clay to the top so that the upper edge of the globe is quite thick. Insert two fingers of the left hand and with the fingers of the right hand outside work the upper edge of the globe into a tall neck. The action is the same as in the shaping of a cylinder except that the diameter is smaller. A good deal of practice will be necessary in order to keep the neck thin and to raise it to any appreciable height, but perseverance will accomplish it.

These lessons if carried out conscientiously will enable the operator to produce almost any form in so far as the manipulation of the clay is concerned but the work up to this point is drill only. It is not intended that the pieces should be preserved. The next point is to insist that the clay obey the potter in the shaping of a form.

A simple drawing of a jar should be made exact to the size proposed. Two or three pairs of calipers are provided and with them the diameter of each part of the drawing is taken. Of course a single pair could be made to serve, but it is very inconvenient to change measurements while working. A piece of wood also is cut to the height of the proposed piece.

PLATE XI. Throwing.—Lesson VII.

PLATE XII. Throwing.—Lesson VIII, 1.

PLATE XIII. THROWING.—LESSON VIII, 2.

The throwing is begun as usual by making a cylinder. This should be higher than the drawing for the clay sinks in the shaping. First the bottom is pressed into the proper size (Lesson VI). Then the body is enlarged to the required measure and, lastly the diameter of the top is taken and the height brought to the determined point. If too high the superfluous clay may be cut off with a pointed knife, the edge being carefully rounded afterwards.

It is only by checking up one's work in some such way as this that real power can be acquired. The skilled worker can think in the clay and create forms at will upon the moving wheel, but for the beginner to attempt this is like an endeavor to paint pictures before one has learned to draw. Shape after shape should be designed, drawn to scale and thrown to measure; in fact, for elaborate pieces no other course is possible.

CHAPTER X

Turning

IT is not possible to finish work to perfection in the operation of throwing. The clay is too soft to handle and for proper finishing the piece must be turned over to get at the bottom. An experienced thrower reduces the final work to a minimum and this, of course, is the ideal plan but even in factory practice every thrown piece is passed on to the turner so that the phrase "thrown and turned" is used as of a single operation, though it, in fact, expresses not only two processes but the work of two men.

The artist-potter must needs, therefore, learn to turn, though this process should not be worked to death as it is liable to be. Many persons in the pride of having produced some sort of a form on the wheel will leave it in the crudest possible condition and trust to the turning tool to remove defects. If the lessons on throwing have been conscientiously carried out, this error will not be committed.

A half dozen cylinders of convenient size should be thrown on separate bats and set aside in a cool place to harden. They must not be dried but should

be in the condition known as "leather hard." If thrown one day they will be ready for turning the next morning. Pieces thus hardened are no longer flexible. They can be handled freely and the clay can be easily cut with a knife.

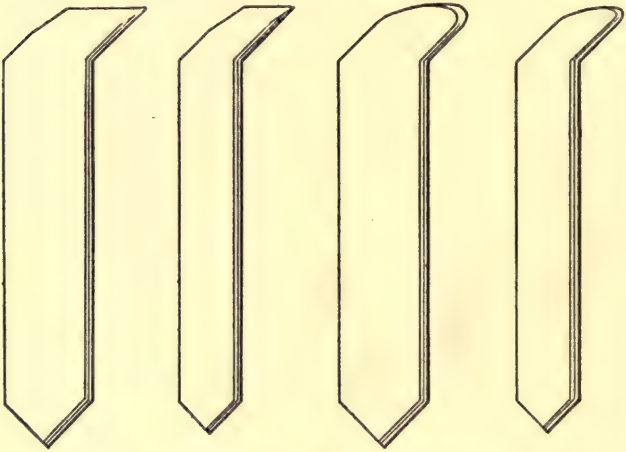

FIG. 19. Turning tools bent and sharpened.

The equipment for turning consists of a board support, a turning stick and a set of tools. The board is of soft pine, eight or ten inches wide and two feet high and is set upright at the back of the wheel frame opposite the workman. It may be screwed in position if it does not interfere with the throwing, or it may be set in a socket so as to be removed when not

in use. Its purpose is to support the end of the turning stick. The stick is an ordinary broomstick in the end of which is a sharpened nail. In use the end of the stick is held in the left hand and the point is pressed into the board at any required height. The right hand, holding the tool, is rested on the stick just as the hand of a painter rests on the mahl-stick.

The turning tools are of soft steel.* They are purchased unshaped and the potter must learn to bend and file them to suit himself. A section of bench should be set apart for filing and care must be taken that the steel dust does not get into the clay.

One of the cylinders, with the bat upon which it was thrown, is now taken in hand. Many beginners try to turn their pieces without detaching them from the bat, trusting to the original adhesion to hold the piece in position. This is a very unsatisfactory plan. A fundamental principle in craft work is that the mechanical difficulties in manipulation should be met and overcome at the first. If one trusts to some method which is apparently easy one walks with crutches and there will come a time, if progress is to be made, when such helps must of necessity be abandoned and then the learning must be begun again. Therefore the student is advised to face the mechanical technique at the very beginning. The cylinder

* The Milligan Hardware Company, East Liverpool, O.

may be turned on the throwing bat, but there is a better way.

The piece should not become so hard that it will release its hold on the bat but with a long bladed knife it should be cut away. If the knife be held close to the bat a separation is easily effected. Set the leather-hard cylinder upon a new bat which is slightly damp and which runs true, on the wheel. The first problem is to center the work. A pencil line may be run upon the bat making a circle just the size of the cylinder. Then as the wheel is revolved it will be seen if the piece runs true. It is quite unlikely that this will be the case. Perhaps the bottom is true but the top circle is untrue. In other words, the axis of the cylinder is not upright. Turn the cylinder upside down and try if it will run any better. If it does the work may be begun in this position. If it does not, turn it back again. Now take a pencil and hold it with a steady hand so that it just touches the near side as the wheel goes round. Lift up the edge of the cylinder on the side marked by the pencil and slip a morsel of clay under it. Revolve the wheel and try with the pencil again. In this way raise or press down one side, keeping the bottom circle in the center until both top and bottom are running as nearly true as they can be made. This, so far, refers only to the horizontal planes. If one side is higher than the other it does not matter at present. Now

take three small pieces of soft clay, and, holding the cylinder firmly with one hand, press them down at equidistant points in the angle where the piece joins the bat. This serves to hold the work in position. A square turning tool of small size is the best to begin with. It is held in the fingers as a pen is held but more firmly. The right hand rests on the turning stick and, the connection between hand and stick being as rigid as possible, both are moved together. This is better at first than moving the right hand freely for to do so will surely result in irregular work.

The tool should be held so as to cut with one corner at first and it is well to take one cut, remove the tool, take another cut and so on. The object should be to feel the clay and to test its resistance. No one can be a successful potter who does not cultivate a sympathy for the clay. The tool is to cut, not to scrape. That is, the cutting edge is to be opposed to the revolving clay. The point at which the tool touches the clay is opposite the center or at the same distance from the operator as the center of the wheel is. If nearer to the workman the tool will not cut; if further away, it will scrape and pull (Fig. 5, page 50).

The first efforts should be directed towards acquiring skill. The student should endeavor to make a cut at any desired point without regarding the effect upon the shape of the cylinder. In other words the clay is used merely as a practice piece. It is not

to be preserved. It is a good plan to keep on turning the first piece until it is all turned away. Too many students fail because they wish to have a piece to keep. He will make the best ultimate success who cares nothing for the preservation of a dozen or two cylinders or other shapes, but uses them merely as exercises in manipulation. If the student is over anxious to avoid spoiling his work, he grows nervous and so loses control of his tools and material. To set no value on the practice pieces themselves begets confidence and this is the surest aid to success.

After two or three cylinders have been centered to the pencil line the attempt to center one free hand may be made. Place a cylinder on the wheel but not quite in the center. Spin the wheel at a medium rate. Fix the attention upon the eccentric motion, trying to forget the circular motion. As the cylinder appears to move from side to side tap it lightly with the hand so as to drive it towards the center. In all probability this will result in driving the cylinder off the wheel altogether. Some little practice is needed, but if persevered in the result will be a power of convenient and rapid centering which is never forgotten and which is the greatest possible help to successful work. One may practice with a wooden cylinder or even a tin can if the weight approximates that of the clay pieces.

Accompanying the practice in turning there should be some exercise in the shaping and filing of tools. Broad tools filed to the proper curve are indispensable in finishing concave surfaces. A curved edge may also be put upon one or two narrow tools. These

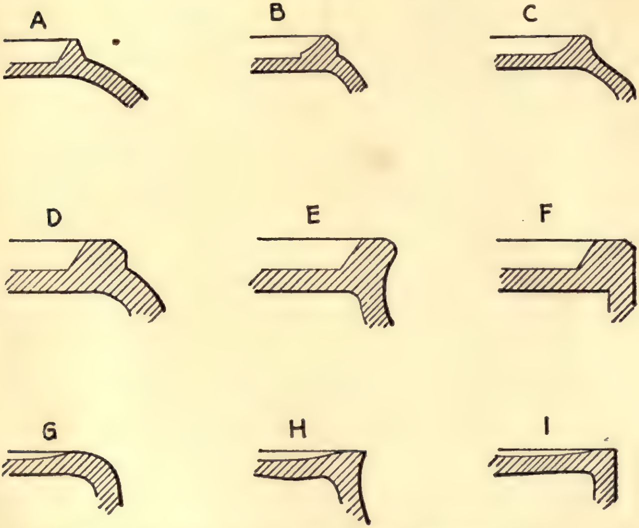

FIG. 20. Turned feet. *A B C*, feet for small pieces. *D E F*, feet for large pieces. *G H I*, common faults in foot finish.

will cut more rapidly than the broader ones but will not leave as smooth a finish. Whatever tool be used the final surface must be worked over with a soft sponge and water so as to eliminate the tool marks

and leave a plastic surface. One of the principal troubles with which the beginner will meet is the vibration of the tool known as "chattering." This is sometimes so slight as not to be felt by the hand but when the motion of the wheel is stopped the work will be found covered with fine ridges like gathering on muslin. The way to prevent this is to avoid using the broad edge of the tool until some experience has been gained. The way to cure it is to go over the work again with a fine pointed tool and then to use the sponge liberally. The point of the tool cuts through the small ribs or wrinkles whereas a broad tool would ride over them and make the trouble worse.

While the whole surface of the work will probably need more or less turning, the chief part of the operation is concerned with the under part or foot. The formation of a good foot marks a good potter and vice versa. Before beginning to turn it should be decided what kind of a foot is desired. Each shape has its own style. Some sketches are given here with an idea of the form to which each is adapted. They are shown upside down because the work is done in this position. The small bevel at the outer angle is used for facility in glazing. A foot finished thus always has a neat appearance when the glaze has been removed from the beveled face.

CHAPTER XI

Making Large Pieces

THERE is a limit in size beyond which the non-professional will not be able to go. Men of life-long experience can throw very large jars but this involves not only more practice than the artist-potter can hope to secure but also great physical strength. On the other hand it is perfectly possible to form vases two or three feet in height by doing the work in parts or sections. No one need fear to put such a plan in operation on account of sentiment. It is, of course, worth while to make large wares in a single piece but section work involves great skill and, as a rule, the result attained is better. Work made in one piece is apt to be badly finished, especially inside, and unduly heavy. Work made in sections can be thrown with thin walls and finished with proper care. If tradition be of any help be it known that the Chinese have used the piece method for hundreds of years, and that the Greeks used it three thousand years ago.

The first requisite is a drawing either actual size or properly scaled. The measurements should be

those of the soft clay and if a particular size be desired in the burned piece, the shrinkage, probably about one-eighth, must be added. The drawing must show the size of each section with the points of junction, and should indicate the upper and lower edges in each case. Some divisions are best made right side up; some are more easily thrown upside down. Care should be taken that the faces which are to be joined are thrown under similar conditions. In every piece of work one face rests on the bat, the other is in the air or free. A bat face should always be joined to a bat face and a free face to a free.

Suppose, for instance, a vase is to be sixteen inches high and is to be thrown in four divisions of four inches each. The bottom division is made first. This will stand in its normal position, right side up. The second section must now be thrown upside down, because, if it were not, its bat face would be joined to the free face of the first piece. So the sections are thrown alternately, every other one being inverted.

As the pieces are thrown they must be carefully measured to see that the faces which are to be united are the same size. The height of each piece also must be gauged and adjusted. The bats with their contents are now set aside to harden. As soon as they can be handled with safety the clay pieces should be removed from the bats upon which the throwing was done and set upon dry bats which will absorb the

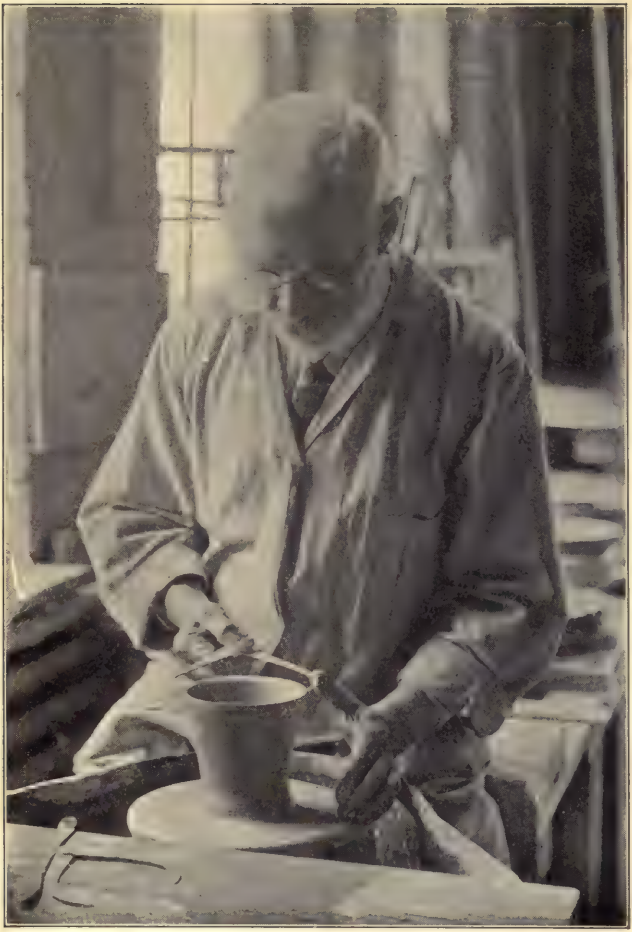

PLATE XIV. Making Large Pieces. The First Section.

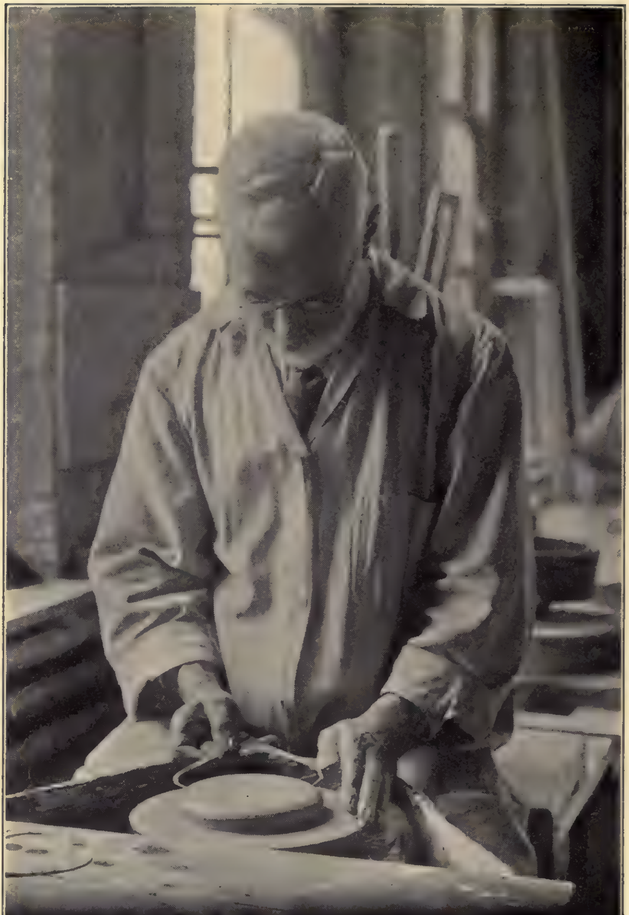

PLATE XV. MAKING LARGE PIECES.
Measuring the Foundation of the Second Section.

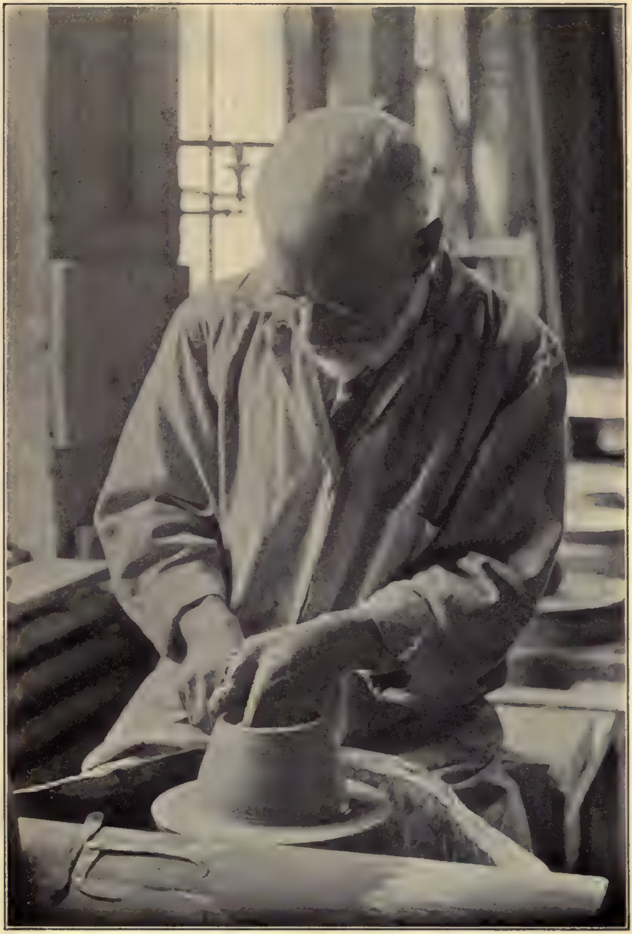

PLATE XVI. Making Large Pieces.
Drawing up the Second Section.

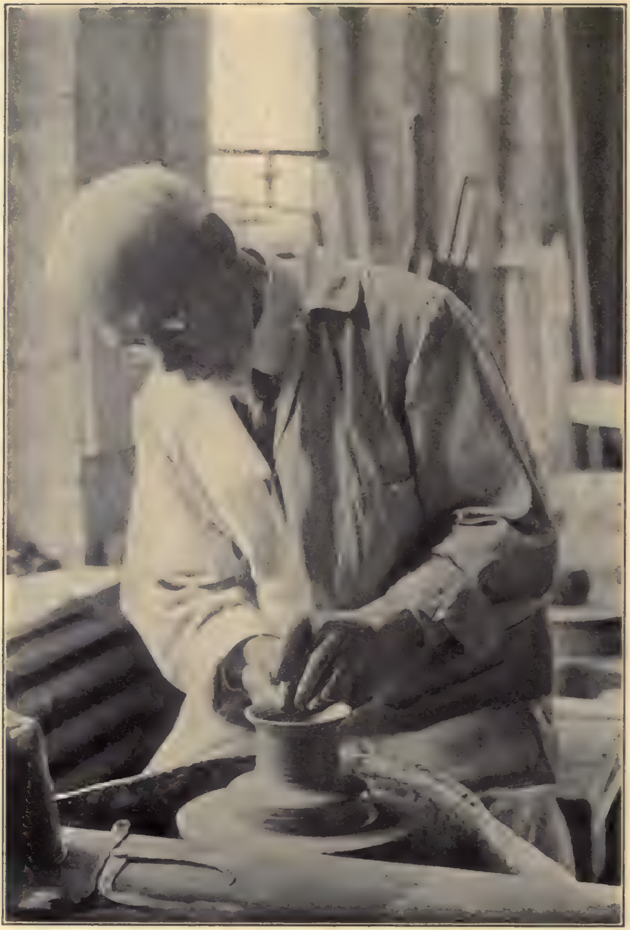

PLATE XVII. Making Large Pieces.
Shaping the Third Section.

PLATE XVIII. Making Large Pieces. The Three Sections Completed.

PLATE XIX. MAKING LARGE PIECES.
Turning the Edge of the First Section. (Note the other sections on the table.)

moisture and help to stiffen the clay. It is a good plan to pile the sections up as they are to stand in the finished piece, one upon another and to leave them so in a cool place for ten or twelve hours. The faces which are to be joined will thus acquire a uniform hardness and unequal shrinkage will be avoided.

When all is ready for the turning, the sections being of the proper hardness are taken in hand. This work should not be hurried. It will take a whole morning to put together a large piece. First, the bottom section is placed on the wheel, centered and made to run true as regards the top edge. It is then inverted and the foot is properly finished, signed and dated. Then the second joint is likewise turned true on both faces, the inside turned smooth; and so on, each piece in turn is prepared for the fitting, the measurement of each face being accurately adjusted. At this stage it is possible to correct the diameter of the faces to some extent either by pressure as the wheel revolves or by building up with soft clay. In either case, however, the new work must be hardened before proceeding. The whole piece is now put together carefully but with dry joints. It should be slowly revolved on the wheel and the proportions carefully criticised. If satisfactory it is taken apart again and the actual fitting up may proceed.

The bottom section is again centered most carefully on the wheel and steadied with three pieces of

PLATE XX. MAKING LARGE PIECES.
Finishing the Bottom of the First Section. (Note the second section in the foreground ready for turning.)

PLATE XXI. Making Large Pieces.
Checking the Size of the Second Section.

clay. A thick slip is now prepared, the same clay as that used for the work being of course, used. This slip must be quite free from lumps and should be as thick as molasses. The upper edge of the work is carefully sponged with clean water and a good coating of slip is applied at the junction. Care must be taken that every part of the face is covered with slip. The second joint is now moistened at the junction and set in position upon the bed of slip. It is placed very lightly and the wheel is gently revolved to see if the running is true. If so it is pressed home and the superfluous slip is removed. The joint should be quite close like a glued joint in carpentry.

In the same way the third section is placed upon the second and the fourth upon the third. It is now possible to work over the face of the vase with a little soft clay. There is almost always some irregularity in the line, especially at the joints, and this must be adjusted while the work is moist. Then the whole face is gone over with turning tools and sponge and the vase is set aside to dry. It must not be expected that large pieces, made by any method, will be produced with as much ease as small vases and bowls. The risks are much greater and, owing to the size of the work, the faults are much more apparent. When the vase is perfectly dry it should be set on the wheel, centered and slowly revolved. If it is very untrue in its motion there is no remedy. It

PLATE XXII. MAKING LARGE PIECES.
Fitting Together Dry.

PLATE XXIII. MAKING LARGE PIECES.
Setting the Third Section in Place.

PLATE XXIV. Making Large Pieces.
The Three Sections Set Together in the Rough.

PLATE XXV. Making Large Pieces.
The Finished Vase.

should be broken down and the clay used again. A very slight irregularity may be corrected by rubbing off a little clay on one side of the foot but this cannot be done to any considerable extent. The courage to break unsatisfactory work is never more valuable than at this juncture. It will pay in the end, for no imperfect piece can be a source of satisfaction to the conscientious craftsman.

CHAPTER XII

Cups and Saucers and Plates

IT is not likely that many craftsmen will care to produce table wares or even that they will be able to acquire the necessary skill. Simple as these wares seem, they are, in fact, the most difficult of all to make well. In factory working, one man makes nothing but cups, another saucers and another plates, so that each attains the skill of constant practice, but this is out of the question for the studio worker. At the same time it is well to know how it is done and it may be that some one will undertake to produce a few pieces for the sake of the enjoyment arising therefrom.

It is possible to finish a cup upon the wheel just as a vase is made. The handle is modeled in clay and fastened in place with slip when in the leather hard condition. Saucers and plates cannot be made in this manner; first, because the broad thin bottom will surely crack and, second, because it is impracticable to turn a plate or saucer over in order to finish the bottom. The risk of breakage is so great that there is nothing to be gained.

If cups be needed of uniform size they must be molded. The making of the molds has already been described. A small cylinder of the proper size is thrown in clay and removed from the wheel while soft. A number of these should be made at one time so as to avoid changing the wheel head often. When all are ready a hollow head shaped to receive the cup mold is set on the wheel and a mold inserted. One of the soft cylinders is now lowered gently into the mold and as the wheel is revolved the soft clay is pressed firmly against the walls with the fingers. A piece of wood, called a rib, cut to the exact shape of the inside of the cup, is used to smooth off the interior. The top edge is cut off and rounded and the mold is set aside for the cup to harden. As soon as the cup can be turned out it is set upside down upon the wheel and the bottom turned.

Another method dispenses with the formation of the cylinder or "lining." A ball of clay of the proper size is dropped into the mold and pressed into shape with the fingers, the wheel, of course, being spun. The finishing is accomplished with the rib as before. This method will answer for wares which are to receive a low fire but for high temperatures the clay must be handled by the first-named plan.

The cup is not complete without a handle. This may be modeled as already stated but to make each

one of half a dozen in this way is unduly tedious. The better plan is to model a handle in wax and make a mold as already directed. A roll of soft clay is then laid in the mold, the two halves pressed together and the handle taken out and finished. Care must be taken that cup and handle are of the same degree of moisture, leather hard, for choice, or they will part company as they dry. The fastening is done with thick slip.

The method for saucers is the same as that for plates, so that one description will suffice. The first step is to make a tool or profile. A large handful of soft clay is rolled out into a thick cylinder and laid down upon the plate mold. It should extend from the center to the circumference, forming a radius of the circle. The clay is pressed closely to the surface of the mold and part of it is squeezed into a knob which will form the hand-hold of the tool (Fig. 16, page 66). The clay is left in this position until it becomes nearly but not quite dry. It is then taken off and whittled into shape. The front edge must be straight and must lie along a radius of the plate. The foot is cut in at the proper point and a broad wedge-shaped hollow is made so as to gather the clay and pile it up into the foot. The hand-hold is shaped so as to fit comfortably between the first and second fingers of the right hand. When properly

shaped the tool is thoroughly dried and then burned in the kiln. The fire must not be severe as it is important not to shrink the tool to any great extent. After burning slight corrections can be made with a file or a hard stone. The heel of the profile must be exactly at the center of the plate and the toe or curve must rest on the outer edge of the plate mold.

In making plates a "batting block" and "batter" are used. The former is a heavy block of plaster which is fixed to a strong table. It must be saturated with water when in use. The wedging table already described will serve for this. The batter is a disc of plaster to which a handle is attached. It may be made of a thick plaster block, the handle being cut out of the substance itself. This is also kept saturated with water so that the clay will not stick. A ball of clay is laid on the block and gently beaten out with the batter into a disc of the proper size and thickness. The face of this is then polished with a steel blade and the disc is then lifted, turned over and laid, polished side downward, upon the mold. The wheel is then revolved and the clay pressed firmly to the mold with wet hands. The tool is now dipped in water and pressed steadily upon the revolving clay. The heel must be adjusted accurately to the center and the foot will be seen to rise up in its proper place. The operation is not easy and many failures

must be expected but practice will accomplish the desired result. When leather hard the plate is gone over with a thin piece of rubber and when quite hard it may be removed from the mold. The edge is now trimmed and the face sponged over and the plate is ready for the kiln.

CHAPTER XIII

Casting

IN commercial production the casting method is constantly used. It is a means of making light and delicate pieces with ease and, of course, all the pieces cast in the same mold are alike. This very fact, however, has led to the method being disregarded by the studio worker who does not wish to duplicate anything that he makes. If a single piece only is to be made the work involved in molding is a waste of time and it is better to strive for skill at the wheel, and yet there are occasions when a knowledge of casting is of great value. In the preparation of trial pieces there is no method better. To make these in sufficient number on the wheel would be tedious except for the benefit of the practice involved.

Directions for making molds have already been given and the slip which will have been prepared in the process of clay making is ready for the casting process. This slip should be thick, about the thickness of buckwheat batter. To be accurate, a pint should weigh 26 ounces. For small pieces or for vases with narrow necks it is advisable to use the

slip rather thinner. For large wares, on the other hand, or for open bowls it may be slightly thicker. A few experiments will show the reason for this. Two quart jugs are needed. They should be large of neck and should deliver their contents freely and completely. Jugs with a deep shoulder are not good as the slip hangs in the pouring. One of these jugs is filled with slip which is to be poured carefully from one to the other, allowing it to flow gently down the side. This is to break the air bubbles which are nearly always found to be present and the pouring should be repeated until the slip flows smooth and even.

The mold, being thoroughly dry, is tied around with twine, if in parts, and wedged firmly so that it cannot leak. The slip is then carefully poured so as not to touch the sides and the mold is filled until a small mound of slip rises over the edge. This mound will at once begin to sink as the water is drawn into the walls of the mold and slip must be added, little by little, to make good the loss. A small quantity of clay will now be found to have stiffened at the rim of the mold and if this be carefully removed with a steel tool the thickness of the wall of the vase will be seen. If not thick enough the mold must be continually filled up until the necessary thickness is attained. The mold is then carefully lifted, making sure that the bottom is held firmly, and the slip is poured out. It

should not be poured back into the casting-jug but into another vessel.

The mold is now set upside down to drain. It should not be placed upon the table but upon two sticks laid parallel so that the drip may hang clear. Several molds may be filled in this way at one time and after about twenty minutes the one first filled may be opened. The bottom is gently detached and the upper part of the mold, consisting of two halves, is laid upon the table on its side. A little gentle manipulation will now suffice to lift the one half and the vase will be seen lying in the other half as in a cradle. The clay is still very soft and must be treated carefully. The half mold, with the contained vase, is taken in the left hand and held nearly upright, the fingers below, the thumb on the top. Now set the fingers of the right hand under the bottom of the vase, rest the thumb lightly against the side and tilt the half mold gently forward. If mold and clay are in good condition the vase will fall forward to be supported on the fingers of the right hand and steadied by the thumb. The half mold is now laid down and the vase taken in both hands, set gently on a plaster bat and put aside to dry. It often happens that the vase leaves the mold with reluctance. If the slip be very new, or the mold either damp or hard or worn out there will be some difficulty in effecting a separation. By allowing the work to stand a while, how-

ever, and by slightly jarring the mold from time to time with the ball of the thumb the piece can generally be removed without damage.

In using a new mold it is customary to make what is called a "waste filling." The mold is filled with slip and at once emptied. After standing a few minutes it is forcibly opened and the thin layer of clay inside is picked out with a ball of plastic clay pressed against it. A tool should never be used as this will damage the face of the mold. If the clay should stick obstinately a soft cloth used over the finger will remove it. The reason for this waste filling is that it removes the scum which occurs on all new molds.

Cast ware should not be touched until quite dry and then the spare at the neck is carefully cut off, the seams scraped down and the whole surface smoothed with fine sand paper and a soft cloth. Worn out linen serves excellently for this purpose.

Cups and bowls, if molded, are made without spare at the top. In this case great care must be taken to see that the edge is left clean and smooth in the casting. The spare neck on a vase acts as a margin of safety, as it is completely cut away in the finishing. If a piece has no spare the edge must be left without blemish at the first.

CHAPTER XIV

Tiles

THERE are two methods of making tiles, the dust-pressed method and the plastic. The former is the more usual commercial plan but the appliances for preparing the dust and the heavy presses necessary are not adapted to studio work. The dust-pressed tile is, moreover, somewhat mechanical in surface. It is not suitable for modeling or for any treatment but those of glaze and color. The plastic tile, on the other hand, may be treated by plastic methods and the surface offers a texture which appeals strongly to the artist.

For the successful production of tile a special body is necessary. Ordinary pottery clay is too close in grain and straight tile cannot be made from it. Small square pieces, however, such as tesseræ, can be made from any clay.

It is presumed that a pure white tile body is not required. For studio work the most pleasing white surface is found in an opaque enamel, but for the most part the craftsman will wish to work for colored tile. A cream or buff body is all that is necessary,

therefore, and the foundation of this is a clay known as sagger clay. In order to secure the necessary porosity a fine "grog" must be used. Grog is burned clay. After working awhile there will be an abundance of this in broken unglazed pottery but at first some soft fire-bricks must be pounded. This is laborious work, but a boy can usually be hired to do it. The brick or broken pottery is crushed in an iron mortar but should not be broken too fine. Two sieves are necessary, one of 20 and one of 40 meshes to the linear inch. The coarse powder which passes through the 20 mesh and lies upon the 40 mesh is used. This is called 20-40 grog. The dust which passes through the 40 mesh may be saved for kiln work. It is useful for setting biscuit pieces one upon another as it will effectually prevent sticking. This powdered grog is also useful in the case of flowing glazes. A thick layer on the bottom of the kiln will catch any drops of glaze and save the kiln from damage.

A quantity of the 20-40 grog having been prepared, a mixture should be made of:—

Sagger Clay	550 parts
20–40 Grog	300 parts
Ground Flint	150 parts

The clay should be finely pulverized and the whole mixed in the dry state. Water is then added, little

by little, until a rather soft mass is obtained. It is not practicable to mix clay of this description by the slip method because the grog would settle out and fall to the bottom of the vessel. It sometimes happens, however, that the stoneware clay contains grains of iron which cause black spots to appear in the tile. If these cause trouble the clay must be made into slip first and lawned through 120 mesh. It is then allowed to become very thick and the grog is stirred in. This is a good deal more trouble than the first named plan and is not often necessary.

Tile are sometimes made in plaster molds. A tile of the proper size is cut from a plaster block and a mold is made from it. If a modeled surface be desired clay may be modeled upon the face of the plaster tile before the mold is made. The mold will then receive the embossment in reverse and all the tiles made from this mold will be alike. The clay is pressed into the mold while quite soft and is scraped off level at the back. Thus it is the face of the tile that is shaped by the plaster. If this plan be adopted the tile must be removed from the mold as soon as possible. If left to dry in the mold they will warp because of the unequal absorption.

A better method has been devised by the author and has been put into practice with considerable success. When the size of the proposed tile has been determined a board is made which is large enough

to hold a square of the tile, say twelve or sixteen. Thus if a tile five inches square is to be made the board would be fifteen by twenty inches for twelve tile or twenty inches square for sixteen. On each side of the board a wooden rim is fastened and this must stand higher than the board to the exact thickness of the tile. About five-eighths of an inch is enough. The board must be perfectly rectangular and tile or twenty inches square for sixteen. On each marked off at even distance of five inches and a shallow groove is cut at each point.

To make the tile the board is wetted and an even coating of grog dust is sprinkled upon it. A ball of clay is laid in the center of the board and rolled out with a rolling pin to fill every part of the frame. With a straight edge the clay is struck off smooth and clean, working always from the center outwards. Reversing the plaster mold method the tile are now face upward and any kind of surface may be given at will. The clay may be lubricated with water and made smooth or it may be sprinkled with grog dust which will give a sandy or toothed finish. The square is now to be cut into tile and this is done with a slender knife and ruler. The ruler should not rest upon the clay but upon thin strips of wood or cardboard which may be laid along the edges for the purpose. The cutting should not go quite through the clay as, if a slight connection be allowed to remain at

the bottom, the tile will keep each other straight. When the cutting is finished the board should be set at an angle of forty-five degrees for the clay to harden. When leather-hard the whole may be turned gently over and the tile allowed to fall on to a board placed in readiness. They are now broken apart, trimmed if necessary and set aside to dry.

Tile made in this way can be kept straight without difficulty and the method is much more expeditious than pressing in plaster molds.

If a modeled surface be intended it is quite easy to work on the tile in the tray while the clay is soft. Forms may be cut in wood and pressed into the clay in any variety and the charm of individual treatment is preserved.

The body given above will prove quite porous when fired but it will take matt glazes well. A little crazing is no detriment to tile because they are not like vessels which are meant to hold water. If a denser body be wished for some of the flint may be replaced by spar.

One of the most attractive methods of decorating tile is by means of a white or delicately tinted enamel and color. The opaque tin enamel given on page 134 will answer well and if the whiteness prove too intense it may be modified by a very small addition of under-glaze color according to the tint desired. The tile should be glazed rather thick. Not as thick as a matt glaze but thicker than bright glazes. The glaze

or enamel should be poured into a flat tray which is large enough to receive one tile. The tile is taken by the edges between fingers and thumb and held face downwards. Do not let either fingers or thumb project beyond the face. The glaze having been well stirred the face of the tile is allowed to rest upon it for about two seconds. The hand is then lifted quickly and reversed so that the tile is face upwards. Every effort should be made to avoid streaks or tears and a little practice will accomplish this. If the glaze shows a bad surface it should be scraped off. It can be mixed up and used again. Sometimes a slight wetting of the tile before glazing will help the surface to flow evenly.

The decoration is carried out with ordinary underglaze colors. These may be mixed together to produce any hue which is sought and a little of the glaze itself, about ten per cent., should be mixed with the color. This will assist in uniting the color with the glaze so that they melt together.

To produce enamel decorations at their true value the color should be painted upon the dry glaze before it is burned. The best relation between surface and color is thus secured. The color must be worked quite thin with water and a little glycerine. A quick, sure stroke is needed as no change or erasure is possible. The design may be made on paper and traced or pounced on to the glaze with lamp-black.

For burning the tile there is nothing better than little fire-clay boxes. These can be made in a mold without difficulty and the inside of each should be washed with glaze. If some such protection be not provided dirt is almost sure to fall on the flat surface and the tile will be spoiled. It is not possible to rear them on edge in the kiln for burning as then the glaze would flow to the lower side and cause an unsightly ridge.

CHAPTER XV

Glazes and Glazing

PART I

MUCH of the fascination of pottery making centers in the glaze. At one time a great deal of mystery appeared to surround the composition and use of glazes, but if one will take the trouble to learn, much of this may be dispelled. Some knowledge of chemistry is desirable if an understanding of the theory of glaze-making is to be acquired, but a good deal may be learned even without this knowledge. Only such simple instruction as can be assimilated by ordinary intelligence will be attempted here, as an exhaustive treatment of the subject would be long and tedious.

It is possible to purchase glazes ready for use* but the true craftsman will not be satisfied until he can prepare his own.

* The Roessler & Hasslacher Chemical Company, 709 6th Avenue, New York City, manufacture glazes according to the recipes of the author, and also chemicals for use in the laboratory.

Glazes* belong to a class of chemical compounds known as silicates; that is, they have silica as the characteristic ingredient. Clear glazes are compound silicates of lead, zinc, lime, potassium, sodium, aluminum and boron. Matt glazes are characterized by certain of these ingredients being present in excess; and stanniferous or tin glazes are, as the name implies, rendered opaque by the use of oxide of tin.

The commonest type of glaze is that which is made from ready prepared, commercial substances. These are called raw glazes as being made from raw materials or materials which need no preparation.

It is possible to mix a glaze in a druggist's mortar by hand, using fine sieves, but if the best results are to be secured, a small mill must be used for grinding. The best form of mill is the ball mill or jar mill. This consists of a porcelain jar which is set in a frame and made to revolve upon its axis in a horizontal position. It is about half filled with porcelain balls and these as they roll against each other perform the grinding. These mills may be purchased ready for use, either as a single jar to be worked by hand or a battery of two or more revolved by power.*

A good pair of scales is a necessity and it will be found convenient to use metric weights which need

* It is admitted that glazes are not chemical combinations but solid solutions, but the principle is more easily understood when the analogy of chemical action is adopted.

* Paul O. Abbé, 30 Broad Street, New York City.

no calculation into pounds and ounces. Suspended scales are not as easy to use as the form known as counter scales or balances. They should have movable pans which are usually nickel plated. Upon these the materials can be placed direct without the use of pieces of paper, which are always troublesome and inaccurate. There should be a graduated bar on the front for the adjustment of weights of five grams and under. This avoids the use of small weights which are always being mislaid and lost. Dealers in chemical supplies keep these scales in stock and the cost is about eight dollars. A set of weights must also be procured from one hundred grams to five grams inclusive. These need not be of the accurate adjustment which are used in analysis. A good inexpensive grade is sufficient.

The ingredients for glazes are given in the following list:

Commercial Name	Chemical Name	Symbol or Formula	Equivalent Weight
White Lead	Lead Carbonate	$Pb(OH)_2 2PbCO_3$	258
Zinc Oxide	Zinc Oxide	ZnO	81
Soda Ash	Sodium Carbonate	Na_2CO_3	106
Niter	Potassium Nitrate	KNO_3	202
Whiting	Calcium Carbonate (Carbonate of Lime)	$CaCO_3$	100
Feldspar	Orthoclase	$K_2O, Al_2O_3, 6SiO_2$	557
Kaolin or China Clay	Aluminum Silicate	$Al_2O_3, 2SiO_2, 2H_2O$	258
Flint	Silica	SiO_2	60
Borax	Sodium di Borate	$Na_2B_4O_7 10H_2O$	382
Boric Acid	Boric Acid	$B_2O_3 3H_2O$	124

For coloring, the following metallic oxides are used:

Color	Chemical Name	Symbol or Formula	Equivalent Weight
Blue	Cobalt Oxide	CoO	80
Blue and Green	Copper Oxide	CuO	79
Gray and Brown	Nickel Oxide	NiO	75
Brown and Yellow	Iron Oxide	Fe_2O_3	160
Brown	Manganese Carbonate	$MnCO_3$	115

Under-glaze colors may also be used for coloring glazes, the color being ground with the glaze batch.

It is not absolutely necessary to commit the formula and equivalent weight to memory. They will soon be remembered as use becomes second nature.

A glaze is usually expressed as the chemical formula. In this there are three divisions given, each of which expresses a distinct function. On the left hand are the bases, the foundation of the glaze. These indicate the type, such as lead glaze, a lime glaze, an alkaline glaze, etc. All glazes being silicates, this is the usual way of distinguishing them. In the center are the alumina and boron oxide. These regulate the behavior of the glaze in the fire. They make it viscous or sluggish as it melts and prevent a too rapid flow. The alumina is infusible, the boron is fusible, but boron cannot be used in a raw glaze for reasons to be presently explained. At the right stands the silica, the dominating factor with which all the other ingre-

dients combine, and which controls the behavior of the whole as regards the fitting of the glaze to the body.

The very simplest form of glaze is a bisilicate of lead, represented by the formula PbO, SiO_2, or one equivalent of lead oxide and one of silica. The term "equivalent" means that the mixture is calculated, not upon the actual weight of a substance but upon its equivalent or unit weight. Thus the equivalent weight of lead oxide, PbO, being 222, in order to produce the formula in actual weight 222 grams or pounds must be weighed out. It does not matter what weights are used so long as they are the same for all.

In like manner the equivalent weight of silica is 60 and as flint is pure silica, the formula PbO, SiO_2 would be produced by weighing—

Litharge or Lead Oxide	222 parts
Flint or Silica	60 parts

Litharge is not, however, a convenient substance to use. It is very heavy and does not mix well in water. The most usual substance for the introduction of lead oxide is white lead. This is not lead oxide but it changes to lead oxide when burned. White lead bears the formula $Pb(OH)_2, 2PbCO_3$, which, being dissected is found to be $3PbO, H_2O, 2CO_2$. H_2O is water and CO_2 carbonic acid, both of which pass off in burning. Both, however, are weighed when the

white lead is put on the scales and therefore the equivalent weight of white lead is 258 and not 222.

The mixture for practical purposes then would be—

White Lead	258 parts
Flint	60 parts

Which, when ground and spread upon the ware would be a very fusible glaze of a yellowish tone.

This was spoken of as a bisilicate of lead because the measure of the silica, also called the acidity of a glaze, is calculated upon the oxygen contained in the base and the silica respectively. PbO contains one molecule of oxygen, SiO_2 contains two. Hence the relationship of the oxygen in the base to the oxygen in the silica is as one to two. This is called simply the "oxygen ratio" and is of great importance in determining the behavior of a glaze. While this simple bisilicate of lead will be a glaze under certain conditions it is found to possess two faults. 1. It is too fluid under fire. The glaze will run down a vertical surface and leave the upper edge of the piece bare. 2. If subjected to a long slow fire it will lose its gloss and become devitrified. This devitrification is often seen in commercial work and appears as a dull scum in patches and around the edges of the ware. It is, in fact, a crystallization of the silica which separates out, as salt does from an evaporated brine. Both these faults may be corrected by the addition of a little alumina to the glaze. A whole equivalent of alumina

would be too much, in fact it is found in practice that .2 equivalent is sufficient for most lowfire glazes. In order to maintain the oxygen ratio and to keep the glaze as a bisilicate the silica content must be raised. Alumina contains three molecules of oxygen so that the total amount of alumina is multiplied by three and the silica brought to the equal point thus:

$$PbO, .2Al_2O_3, 1.6SiO_2$$

The amount of silica required in any bisilicate glaze may be found by the following equation:

$$SiO_2 = \frac{2(3Al_2O_3 + 1)}{2}$$

Thus if the alumina content were .25 equivalent this would be expressed:

$$SiO_2 = \frac{2(.75 + 1)}{2}$$

Or—

$$SiO_2 = \frac{3.50}{2} = 1.75 \text{ equivalent}$$

Now in order to produce this as a mixture it would be possible to introduce the alumina in the pure state, but pure alumina is expensive and clay which contains alumina is cheap so that clay is generally used to supply the alumina. Clay, however, contains silica as well, and therefore allowance must be made for this. On referring to the formula for kaolin, the purest form of clay, Al_2O_3, $2SiO_2$, $2H_2O$, it will be seen that there is twice as much silica present in equivalence as there

is alumina and therefore .2 kaolin will contain $.2Al_2O_3$ and $.4SiO_2$. Subtracting, then, the $.4SiO_2$ from the $1.6SiO_2$ needed there will be 1.2 left to be supplied in the form of flint. The mixture therefore is—

White Lead	1.0 × 208 = 258
Kaolin	.2 × 258 = 51.6
Flint	1.2 × 60 = 72

This is a glaze of the same character as that first given except that it no longer flows unduly from the higher places nor will it devitrify in a long-continued fire. The alumina will have counteracted both these evils.

A glaze with only lead oxide as the base is not, however, desirable for general use. The color is yellowish and the lead oxide is apt to destroy the hue of any colors which are used with it. The available bases may be classified under three heads. 1. The metallic oxides, lead and zinc oxides. 2. The alkaline earths, the oxides of calcium and barium. 3. The alkalies, potash and soda. Barium oxide is not often used and soda cannot be used in raw glazes because there is no convenient substance which contains it. As glazes are always ground in water only insoluble ingredients can be employed without preparation. Potash is found in feldspar which is insoluble and while there is a so-called soda feldspar it can rarely be obtained of sufficient purity.

In arranging the bases with which to compose a glaze it is desirable to use one at least from each class, but it must be borne in mind that however many bases are introduced the total must always be unity. This unit is, for the sake of brevity, described as RO. For example the following groups may be set forth:

1. PbO Lead Oxide	.7	2. PbO	.6
CaO Calcium Oxide	.3	CaO	.4
RO	1.0	RO	1.0
3. PbO Lead Oxide	.5	4. PbO	.6
ZnO Zinc Oxide	.2	ZnO	.1
CaO Calcium Oxide	.3	CaO	.3
RO	1.0	RO	1.0
5. PbO Lead Oxide	.6	6. PbO	.50
CaO Calcium Oxide	.3	CaO	.35
K_2O Potassium Oxide	.1	K_2O	.15
RO	1.0	RO	1.00
7. PbO Lead Oxide	.45	8. PbO	.35
ZnO Zinc Oxide	.10	ZnO	.15
CaO Calcium Oxide	.30	CaO	.35
K_2O Potassium Oxide	.15	K_2O	.15
RO	1.00	RO	1.00

The reason for the unit rule is that if one formula is to be compared with another there must be a uniform basis upon which to work and, furthermore, it makes no difference whether the silica combines with one, two, three, or four bases, the chemical action is the same and, so long as the sum of the bases is kept at unity, the same amount of silica will be required.

If two glazes be taken as an illustration this will be made clear:

$$\left.\begin{array}{ll} PbO \dots\dots & .6 \\ CaO \dots\dots & .4 \\ \hline & 1.0 \end{array}\right\} \quad Al_2O_3 \dots\dots .2 \quad SiO_2 \dots\dots 1.6$$

$$\left.\begin{array}{ll} PbO \dots\dots & .46 \\ ZnO \dots\dots & .12 \\ CaO \dots\dots & .28 \\ K_2O \dots\dots & .14 \\ \hline & 1.00 \end{array}\right\} \quad Al_2O_3 \dots\dots .2 \quad SiO_2 \dots\dots 1.6$$

Both of these formulae are bisilicates and each being properly fired, will stand, without crazing, on the same body.

The use of the formula is to give an insight into the composition of the melted glaze. It takes no account of volatile ingredients or losses in the fire but for this very reason it must be translated into the substances to be weighed before use can be made of it.

Of the ingredients given on pages 142, 143, some contain but one item of the formula, others contain several, as in the case of kaolin already cited. Feldspar, of the variety known as potash feldspar and named by mineralogists, "orthoclase," is a very useful ingredient in raw glazes, being, in fact, almost the only source of potash. The formula, page 142, shows that a molecule or equivalent of feldspar contains one molecule of potash K_2O, one of alumina Al_2O_3, and six of silica SiO_2. This fact is taken into account in calculating the mixture or batch weight.

Base No. 5 (page 148), is as follows:

PbO	.6
CaO	.3
K_2O	.1
	1.0

And this made up into a bisilicate glaze would be:

$$\left.\begin{array}{ll} PbO & .6 \\ CaO & .3 \\ K_2O & .1 \\ \hline & 1.0 \end{array}\right\} Al_2O_3 \;\ldots\; .2 \quad SiO_2 \;\ldots\; 1.6$$

These items are extended in a horizontal line, a space being left on one side for the list of ingredients.

	PbO	CaO	K_2O	Al_2O_3	SiO_2		
	.6	.3	.1	.2	1.6		
Addition	.6					White Lead	.6
Subtraction	.0	.3	.1	.2	1.6		
Addition		.3				Whiting	.3
Subtraction		.0	.1	.2	1.6		
Addition			.1	.1	.6	Feldspar	.1
Subtraction			.0	.1	1.0		
Addition				.1	.2	Kaolin	.1
Subtraction				.0	.8		
Addition					.8	Flint	.8
Subtraction					.0		

Each item is thus disposed of until the list is complete. These figures are, however, given in equivalents and each must be multiplied by the equivalent weight of the substance used.

White Lead	.6 × 258 =	154.8	parts by weight
Whiting (calcium carbonate)	.3 × 100 =	30.0	" " "
Feldspar	.1 × 557 =	55.7	" " "
Kaolin	.1 × 258 =	25.8	" " "
Flint	.8 × 60 =	48.0	" " "
		314.3	Batch of Glaze

These amounts are weighed out in grams, put upon the mill with half a pint of water, and ground for about an hour. When taken off, the jar and porcelain balls are washed with plenty of water and the washings saved. The glaze, thus diluted, is strained through a lawn of 120 mesh and laid aside to settle. The clear water is then siphoned or poured off and the glaze is ready for use.

For glazing the glaze should be as thick as cream. A finger dipped into it should show a white coating which cannot be shaken off. The pottery to be glazed should be first soaked in clean water until all absorption has ceased. It is then wiped dry and plunged into the glaze bath, or, if the piece be large, the glaze may be poured over it. The piece is gently shaken to distribute the glaze evenly and it is then set aside to dry. Before glazing a piece everything should be prepared. A stilt or support upon which to set the wet glazed pottery, and a bowl of water in which to wash the fingers so as to save all the glaze. It will be found best to glaze the inside of the piece first. It should then be well shaken to remove as much glaze

as possible before beginning the outside. A thick glaze inside is almost sure to run down to the bottom where it will form a pool and perhaps burst the piece.

Before firing, the bottom of the pottery should be carefully trimmed. Any excess of glaze is removed and the point of contact with the table is sponged clean. Then, when the piece is set in the kiln the bottom will not be inclined to stick.

PART II

Matt Glazes

THE texture of the matt glaze is always pleasing and the artist is not content unless at least some of his work can be finished in this way.

Matt glazes are not underfired glazes nor are they deadened by acid or sand blast. They are produced in two ways. First, by an excess of alumina which is believed to cause the formation of certain compounds in the glaze, and, second, by an excess of silica which produces a devitrified surface. It was mentioned in the last chapter that a glaze free from alumina will devitrify or become dull. This is undesirable when a glaze is intended to be brilliant but it may be controlled and turned to advantage in the

production of a certain type of matt. The successful preparation of this silica matt is extremely difficult. In fact, in the studio kiln it is almost impossible. These small kilns are apt to cool with great rapidity whereas, in order to produce the silica matt the kiln must be cooled very slowly, hours and even days of cooling being sometimes necessary.

The alumina matt is more simple and its texture is quite satisfactory, being, in the opinion of some, the more pleasing of the two.

It was mentioned in the last chapter that the best bright glazes for low temperature work are bisilicates, having an oxygen ratio of 1 : 2. The alumina matt has an oxygen ratio of about 3:4. This is secured in the following manner. The RO content may consist of any of the bases used in bright glazes, the proportion of each being adjusted in accordance with the desired point of fusion. The alumina content is rather higher than in a bright glaze and should not fall much below .3 equivalent, .35 equivalent is even better. The silica is adjusted in accordance with the following equation:

$$SiO_2 = \frac{3(3Al_2O_3 + 1)}{4}$$

Now if the alumina content be placed at .35 equiva-

lent this would work out:

$$SiO_2 = \frac{3(1.05+1)}{4}$$

Or:

$$SiO_2 = \frac{6.15}{4} = 1.5375$$

But as such a complete fraction is not necessary it may be stated as 1.54 equivalent. The formula would therefore be:

$$RO,\ Al_2O_3\ .35,\ SiO_2\ 1.54$$

The RO content should not be too fusible. Lead oxide is desirable up to about .5 equivalent and it is an advantage to use feldspar so that K_2O may be introduced. Calcium oxide is also good but zinc oxide must be used sparingly as it is apt to suffer if overfired. The high content of alumina necessitates a good deal of clay and as this, if used raw, would make the glaze too plastic and cause it to crack, it is best to calcine a part of it, thus removing the combined water and changing the equivalent weight from 258 to 222. The calculation will then proceed as in the case of a bright glaze.

$$\left.\begin{array}{l} PbO \ldots\ldots .50 \\ CaO \ldots\ldots .35 \\ K_2O \ldots\ldots .15 \\ \hline RO \ldots 1.00 \end{array}\right\} Al_2O_3 \ldots\ldots .35 \quad SiO_2 \ldots\ldots 1.54$$

	PbO	CaO	K_2O	Al_2O_3	SiO_2		
	.50	.35	.15	.35	1.54		
Addition	.50					White Lead ..	.50 × 258 = 129
Subtraction	.0	.35	.15	.35	1.54		
Addition		.35				Whiting	.35 × 100 = 35
Subtraction		.0	.15	.35	1.54		
Addition			.15	.15	.90	Feldspar	.15 × 557 = 83
Subtraction			.0	.20	.64		
Addition				.15	.30	Calcined Kaolin	.15 × 222 = 33
Subtraction				.05	.34		
Addition				.05	.10	Kaolin	.05 × 258 = 13
Subtraction				.0	.24		
Addition					.24	Flint	.24 × 60 = 14
Subtraction					.0		

The mix, therefore, is:

White Lead	129	grams
Whiting	35	"
Feldspar	83	"
Calcined Kaolin	33	"
Kaolin	13	"
Flint	14	"

This will give a silky matt glaze, nearly white, maturing at about cone 1. If a lower fusing point is desired the white lead may be increased at the expense of the whiting or if the glaze prove too fusible the reverse will correct it. The flint may be omitted without damage.

The grinding of a matt glaze is of great importance. It is better to have it too coarse than too fine. Grinding for one hour on the ball mill should be ample and if the glaze be then strained through 120 mesh lawn all coarse particles will be arrested. A glaze that is too fine will crack and peel off or will curl up in the kiln.

More than half the success of matt glazes lies in the using. It is necessary that the coating of glaze be very thick or the true texture will not be developed. When the glaze is taken from the mill plenty of water may be used in order to wash the apparatus clean and to save all the glaze. This is set aside in a deep bowl to settle. After some hours the clear water is carefully drawn off with a siphon.

Half an ounce of gum tragacanth is put to soak in a quart of clean water. After twelve hours the gum will have swollen to a jelly-like mass. This is now worked vigorously with a Dover egg-beater or in a Christy mixer and again set aside. After another twelve hours the operation is repeated and the solution is a clear syrup of the consistency of thin molasses. A drop or two of carbolic acid or other germicide should be added to prevent decomposition. This mucilage should be prepared in advance. To the glaze batch from which the water has been removed a tablespoonful of the mucilage is added. If more of the glaze than the single batch has been weighed out then more mucilage will be necessary. The mixture is to be stirred very thoroughly and it will be found to thicken under the hand. It must be very much thicker than the bright glaze. In fact, the thicker it is the better, only that it must flow sufficiently so that the pottery may be covered with a smooth coating, avoiding lumps. Matt glazes do not correct

their own faults in the kiln as bright glazes do. Every finger mark will show and, consequently, the glazing must be done with the greatest care. The process is the same as that described for bright glazes, except that as much glaze as possible is left on the ware. No more shaking should be done than will suffice to secure a smooth coating. It is well to place the pieces upside down to dry.

For the inside of the pieces a matt glaze may be used or a thin coat of clear glaze at the pleasure of the worker. If the latter, care must be taken that none of the inside glaze is allowed to run over the edge.

In firing, the pottery is sometimes placed on a stilt but this is not absolutely necessary. For a support a flat piece of burned clay may be used and this should be covered with an infusible wash to prevent any possibility of sticking. Equal parts of kaolin and flint make a good wash. The wash is worked up with water into a slip and applied with an ordinary brush.

PART III

Fritted Glazes

FRITTED glazes, like raw glazes, are clear and brilliant and for most purposes the latter will suffice. Since, however, the aim of this work is to

give as complete information as may be the fritted glaze will not be omitted.

A fritt is a melt or compounded glass and the purpose of it is to permit the use of certain ingredients which are not available in the raw state. As glazes are ground in water it is essential that the substances used be insoluble. This condition would prohibit advantage being taken of borax, boric acid, and soda ash, if it were not for the possibility of rendering these insoluble by the operation of fritting.

The following is an example of a fritted glaze:

$$\left.\begin{array}{l} \text{PbO Lead Oxide} \ .30 \\ \text{ZnO Zinc Oxide} \ .15 \\ \text{CaO Lime} \ \ldots\ldots \ .25 \\ Na_2O \text{ Soda} \ \ldots\ldots \ .20 \\ K_2O \text{ Potash} \ \ldots\ldots \ .10 \end{array}\right\} \left.\begin{array}{l} Al_2O_3 \text{ Alumina } .15 \\ B_2O_3 \text{ Boric Acid } .40 \end{array}\right\} SiO_2 \text{ Silica} \ \ldots \ 2.65$$

This will be produced in accordance with the usual calculation by the mix:

White Lead	.3 × 258 = 77
Zinc Oxide	.15 × 81 = 12
Whiting	.25 × 100 = 25
Borax	.20 × 382 = 76
Feldspar	.10 × 557 = 56
Kaolin	.05 × 258 = 13
Flint	1.95 × 60 = 117

The borax contains the required amount of both soda and boric acid and the potash is supplied by the

feldspar. Borax, being soluble, must be melted with certain other ingredients into an insoluble glass, thus:

Fritt:

Borax	76 x 2 = 152
Whiting	25 x 2 = 50
Feldspar	30 x 2 = 60
Flint	50 x 2 = 100
	362

These ingredients are weighed out in double quantity to guard against loss in melting and are fused either in the kiln or in a special furnace. A good fritting furnace is the No. 15, made by the Buffalo Dental Manufacturing Company. The charge is put into a plumbago crucible and when melted is poured out into water. This breaks up the fritt and renders it easy to grind. A similar crucible may be used in the kiln but as the fritt becomes very hard when cold and a crucible must be broken each time, the furnace method is better. If the fritt as given prove too sluggish to pour freely, the feldspar may be omitted, being added, of course, to the glaze mix. The melted weight of the fritt must now be calculated.

Borax contains in each equivalent 180 parts water. Whiting contains in each equivalent 44 parts carbonic acid. Both water and carbonic acid pass off in the melting, thus the 76 parts of borax will be reduced in weight to 40 parts, and the 25 parts of whiting

will be reduced to 14 parts. Spar and flint undergo no loss. The fritt after melting will therefore be:

Borax	40
Whiting	14
Spar	30
Flint	50
	134

And the final mix for the glaze will be:

Fritt	134	parts
White Lead	77	"
Zinc Oxide	12	"
Feldspar	26	"
Kaolin	13	"
Flint	67	"

This is ground on the mill as already directed and is ready for use.

Fritted glazes are better than raw glazes for certain classes of ware. They are usually whiter and less easily scratched. They are, moreover, better for use with underglaze colors and are, as a rule, more easily melted. It is never necessary to make a fritt for the preparation of matt glazes.

PART IV

Recipes

WHILE the purpose of this work is not so much to put ready-made materials into the hands of the craftsman as to enable him to work out his own plans, it is recognized that there are some workers

who lack the training and even the patience to do this. For these, the following recipes are given, but with the proviso that no recipe can be regarded as perfect for all conditions. Just as an untrained cook can spoil a dinner even when surrounded by cookery books, so the best of recipes will fail when unskillfully treated. One must be prepared to recognize the faults which are sure to develop and to correct them in an intelligent manner. The previous chapters should therefore be carefully studied, not alone for the information but because "the joy of the working" depends greatly upon the knowledge one has of the operations involved and a modest confidence in one's own powers.

1. Bright raw glaze.

Cone .06 — Formula

$$\left.\begin{array}{l} PbO \ldots .60 \\ CaO \ldots .25 \\ K_2O \ldots .15 \end{array}\right\} \quad Al_2O_3 \ldots .15 \quad SiO_2 \ldots 1.45$$

Mix:

White Lead	155
Whiting	25
Feldspar	55.7
Kaolin	13
Flint	45

Grind, with one-half pint of water, for one hour.

2. Bright raw glaze.

Cone 1 — Formula

$$\left.\begin{array}{l} PbO \ldots .45 \\ ZnO \ldots .15 \\ CaO \ldots .25 \\ K_2O \ldots .15 \end{array}\right\} \quad Al_2O_3 \ldots .20 \quad SiO_2 \ldots 1.60$$

Mix:

White Lead	116
Whiting	25
Zinc Oxide	12
Feldspar	83
Kaolin	13
Flint	36

3. Bright fritted glaze.

Cone .02 Formula

$$\left.\begin{array}{l} PbO \ldots .25 \\ ZnO \ldots .15 \\ CaO \ldots .30 \\ Na_2O \ldots .20 \\ K_2O \ldots .10 \end{array}\right\} \left.\begin{array}{l} Al_2O_3 \ldots .15 \\ B_2O_3 \ldots .30 \end{array}\right\} SiO_2 \ldots 2.35$$

Mix:

Fritt		Glaze	
Borax	114	Fritt	117
Whiting	60	White Lead	64
Soda Ash	10	Zinc Oxide	12
Spar	56	Spar	28
Flint	78	Kaolin	13
		Flint	60

Grind as before.

4. Matt glaze.

Cone .02 Formula

$$\left.\begin{array}{l} PbO \ldots .50 \\ CaO \ldots .30 \\ K_2O \ldots .20 \end{array}\right\} Al_2O_3 \ldots .34 \quad SiO_2 \ldots 1.48$$

Mix:

White Lead	129
Whiting	30
Spar	111
Calcined Kaolin	22
Kaolin	11

5. Matt glaze.

Cone 7 Formula

$$\left.\begin{array}{l} CaO \ldots .75 \\ K_2O \ldots .25 \end{array}\right\} Al_2O_3 \ldots .55 \quad SiO_2 \ldots 2.10$$

Mix:

Feldspar	139
Whiting	75
Calcined Kaolin	55
Kaolin	13

For colored glazes add to any of the above:

Blue:	
Cobalt Oxide	3 parts
Slate blue:	
Cobalt Oxide	3 parts
Nickel Oxide	1 part
Warm blue:	
Cobalt Oxide	2 parts
Iron Oxide	1 part
Green:	
Copper Oxide	8 parts
Blue green:	
Copper Oxide	8 parts
Cobalt Oxide	1 part
Cool green:	
Copper Oxide	8 parts
Cobalt Oxide	1 part
Nickel Oxide	2 parts
Olive green:	
Copper Oxide	6 parts
Iron Oxide	4 parts
Orange brown:	
Iron Oxide	8 parts
Red brown:	
Iron Oxide	8 parts
Chrome Oxide	1 part
Zinc Oxide	3 parts
Yellow:	
Uranium Oxide	3 parts

The coloring oxides should be weighed out and ground with the glaze. Any of the colors may be mixed together in order to modify the hue obtained

or the amount of each coloring oxide may be varied to give a stronger or weaker value.

Opaque tin enamel.

Cone .02 Formula

$$\left.\begin{array}{ll} PbO \ldots\ldots & .40 \\ CaO \ldots\ldots & .25 \\ K_2O \ldots\ldots & .20 \\ ZnO \ldots\ldots & .15 \end{array}\right\} Al_2O_3 \ldots\ldots .25 \left\{\begin{array}{ll} SiO_2 \ldots\ldots & 1.75 \\ SnO_2 \ldots\ldots & .30 \end{array}\right.$$

Mixture:

White Lead	103
Whiting	25
Feldspar	111
Zinc Oxide	12
Kaolin	13
Flint	27
Tin Oxide	45

Grind, with one-half pint of water, for 45 minutes.

PART V

The Defects of Glazes

WHILE it may chance that body and glaze and fire are so adjusted that faults do not develop, this state of things is rare. Besides, it is always possible that an occasional trouble may arise, hence it will be well to recount a few of the commonest defects with the method of cure. A cure is not necessarily specific. There may be a complication of causes but the remedy indicates the line along which relief will be found.

1. Crazing. Fine cracks appear in the glaze but do not penetrate the body. There are many causes. The body may be underfired or overfired. In the former case the crazing does not always appear at once and it grows worse upon standing. In the latter case the glaze is found to be crazed when taken from the kiln and it does not extend even after long standing. The glaze may be underfired. In this case the lines of the crack are broken and irregular, one often changing its direction without meeting another crack In all these cases the remedy is obvious.

Crazing also occurs when both body and glaze are correctly fired but there is an inherent disagreement in expansion. In such a case a little flint added either to the body or to the glaze will tend to cure the trouble but it must be remembered that the addition of flint to the glaze is apt to render it less fusible and therefore while one craze may be cured another may be caused. The addition of flint to the body is the simplest remedy.

2. Shivering or peeling. This is the reverse of crazing and is caused by the glaze being too large for the body. It almost always appears immediately the ware is cooled. The symptoms are that edges or convex surfaces are pushed off and even the ware itself is shattered. The remedy is to decrease the flint in either body or glaze.

3. Blistering. Glazes, both bright and matt, are apt to develop blisters at times. These may be yet unbroken when the kiln is opened or they may have melted down to a small crater, a ring with a depression in the center. The cause of this fault is usually to be found in the body. All clays contain sulphur and when a clay is aged this develops an acid which rises to the surface of the ware when dried and causes a scum. The glaze attacks this sulphate scum and a gas is generated which boils out and causes the blisters. If old clay blisters and new clay does not it may be regarded as certain that this is the cause. A little barium carbonate added to the clay will help to effect a cure. About one per cent. is usually enough. Clay so treated, however, must not be used in plaster molds as the barium attacks the plaster. If the cause be not found in the clay it may exist in the glaze itself. Some glaze ingredients contain impurities in the form of sulphates and these will cause blisters.

4. The glaze flows, leaving bare places. It is too fluid, add a little clay and flint.

5. A matt glaze burns to a bright surface. Matt glazes must be used in a very thick coat. If too thin they will inevitably brighten. The fire may be too high. The fire may be "reducing," that is, with insufficient air.

6. The glaze crawls or rolls up in lumps. Notice whether the glaze is cracked before burning. If so

it will surely crawl. Too fine grinding is usually the cause of this trouble. Too much clay in the glaze may cause it, or a too porous body. A body which is underfired will almost certainly cause the glaze to crawl.

7. Pinholes appear in the glaze when cool. Too rapid cooling is the cause.

PART VI

Alkaline Glazes

THE glory of the Persian and Egyptian blue is too alluring for potters to withstand. Though the pursuit of this glory leads one into all kinds of disasters and failures, the avenues of research that it opens add unending fascination to the study. Even one beautiful glowing pot out of twenty or more efforts is a stimulating achievement though it should not be thought that this is the usual proportion.

It is a continual source of astonishment that with a slight variation of glaze formula a positive green will swim into a vibrating blue. The addition or substitution of one substance or another in the glaze mix may be the key to an unexpected transformation and may give the potter a new palette of color.

The clay body has a very positive effect on alkaline glaze both in its composition and its color. This is

especially true under a transparent glaze where the effect is considerable since the color of the glaze would be modified by the red or buff clay showing through.

If, therefore, the object of the potter is to obtain a brilliant " Persian " blue, a white clay body must be composed or a white *engobe* applied over the buff or red clay to hide the color.

The Persians and Egyptians used a coarse, sandy body high in silica and covered the roughness of the clay with a fine white *engobe* on which they painted their decorations in various colors. The whole was finally covered with the transparent alkaline glaze.

While the effect of colored clay under opaque glaze is less pronounced, it still makes sufficient difference to be considered.

The word *engobe* is French and refers to a thin coating of clay, also called a slip, laid over a colored body to change the color or over a coarse body to give a finer texture.

The *engobe* is usually composed of china clay, flint, and feldspar much as a white earthenware body is constituted but with a larger content of flint. Ball clay may also be used but the color is not so white. The mixture of porcelain given on page forty will make an *engobe* suitable for many clay bodies. If it should crack on drying more flint should be added.

An *engobe* must, of course, be put upon the unburned or green clay ware and this should be leather

hard, not dry. The body with the *engobe* may be burned before glazing or the glaze may be put upon the unburned ware and the whole subjected to one fire only.

The ingredients in alkaline glazes are soda-ash, whiting, feldspar, flint and oxide of tin. The following is an example of a fritted glaze:

$$\left.\begin{array}{l} Na_2O \ldots\ldots .60 \\ K_2O \ldots\ldots .10 \\ CaO \ldots\ldots .30 \end{array}\right\} Al_2O_3 \ldots\ldots .10 \quad SiO_2 \ldots\ldots 1.30$$

Soda Ash	64
Whiting	30
Feldspar	56
Flint	42

The entire batch is fritted and ground in a ball mill with the usual amount of water for fritt grinding, adding a tablespoonful of gum tragacanth mucilage to the batch after it is sieved. The glaze should be the consistency of heavy cream when used.

It is also possible to use an alkaline glaze in the raw or unfritted state. This necessitates grinding by hand in a mortar, but great care must be taken to mix the dry ingredients thoroughly before adding water and to stir the glaze constantly while pouring in the water, otherwise the soda-ash will cake and harden and be very difficult to break up. A batch of glaze can be ground by hand in fifteen or twenty minutes if done vigorously. It is then put through a 120-mesh sieve. The consistency is of importance. If too much

water has been added and the glaze has become thin, it cannot be used successfully and should be discarded. Unfritted alkaline glaze does not keep well when moist but the ingredients can be ground dry and kept ready to be moistened as needed.

The following is an example of an unfritted alkaline glaze:

$$\left.\begin{array}{l} Na_2O \ldots\ldots .59 \\ CaO \ldots\ldots .21 \\ K_2O \ldots\ldots .20 \end{array}\right\} \quad Al_2O_3 \ldots\ldots .20 \quad SiO_2 \ldots\ldots 1.6$$

Soda Ash	62
Whiting	21
Feldspar	111
Flint	24

For color add the following oxides to a batch.

1. Egyptian blue, opaque — from 5 to 8 grams of black oxide of copper — 16 grams of oxide of tin.
2. Persian blue, opaque — from 8 to 10 grams of black oxide of copper — 16 grams of oxide of tin.
3. Sapphire blue — 1 gram black oxide of cobalt.
4. Aubergine — 9 grams black oxide of manganese.

The clear glaze without any coloring oxide can be used over any of the colored glazes. This is sometimes necessary when the colored glaze contains such a large proportion of coloring oxide as to show black on the surface.

The application of alkaline glaze is very important. Any of the three methods of pouring, dipping, and brushing can be employed. Brushing seems to give

the best results but the glaze must be put on thick, in two or three coats, to give quality.

The firing is interesting and important because of the varied effects it develops from the same formula. The range of temperature is great, varying from cone .05 to 1, developing the alkaline glaze according to the result desired. If the biscuit is soft fired the color will be more intense; if hard fired, the color will be much lighter in value with a high sheen on the surface. An unfritted alkaline glaze burned to .05 develops a soft matt finish.

Where the color of a transparent Persian blue comes out olive green, too little glaze has been used on the piece or the buff of the clay has modified the color. Bubbles mean undeveloped glaze or sulphur in the clay or fuel. Black scum shows an excess of copper in the batch, or reduction in the fire. Sand paper surface proves too low firing or too thin a glaze.

If one desires to reproduce the underglaze Persian decoration the black outlines may be drawn with a black underglaze color mixed with clay. A little mucilage must be added to secure smooth working. The turquoise blue is copper oxide, the dark blue cobalt, and the purple manganese. The oxides must be diluted with white clay and used rather thin. The Rhodian red is a finely ground red burning clay mixed with a little flint. This red must be laid on quite thickly. It will probably be found necessary to fire the painted

decoration to about cone .03 before glazing. The glaze may be either quite clear or slightly tinted. Another effect may be produced by using the black outline alone under a peacock blue or turquoise glaze.

A great many modifications and additions to this subject will suggest themselves to the potter as he works, and a continual study of the masterpieces of the Persians in the museums will prove the greatest inspiration.

CHAPTER XVI

Decoration

THE necessity for some kind of decoration upon the clay will always be a point of difference amongst artists. Some prefer the simple form with a glaze treatment only, others consider that the surface should be broken up by design. The question will not be debated here. The aim of this hand-book is instruction and the individuality of the worker is to be encouraged. Directions for executing the different treatments do not imply that these elaborations are advocated. That must be left to the inspiration of the worker.

Decorations may be applied upon the soft clay by incising, inlaying and embossing; upon the dry clay or upon the burned pottery in color under the glaze or with no glaze at all; in the glaze by the use of colors or colored glazes; or over the glaze with colors and enamels. Each of these methods possesses special features. Each has its own possibilities and limitations and these should be mastered by the craftsman.

As in the production of form a well-planned design should be prepared. The first sketch should be made

on paper or on a slab of clay but the fitting and final arrangement are best made on the piece itself.

Incising consists in the excavation of a shallow trench or trough on the surface of the clay. The vase or jar having been finished should be kept in a damp place so that the clay does not dry out completely. The design may be made in India ink with a brush. A steel tool with a narrow chisel end is used for cutting and care must be taken that the clay is in such a condition of moisture as will admit of a clean trench being dug without any rough or broken edges. The bottom of the trench need not be very smooth but the edges should be sharp and the lines well defined. At the same time a mechanical hardness of finish is to be avoided. The plastic nature of the clay should be kept in mind and every surface, though decided in character, should be soft and expressive. This result can be secured by working over the cutting with a moist camel-hair brush. The work must not be mopped so as to leave a woolly effect, but a little sympathetic penciling will remove the hard lines of the tool.

There are two possible developments of incised work. The details of the design may be excavated or the background may be cut out leaving the drawing in relief.

In modeling embossments the piece should be a little softer than for incising. It is important that in

any clay work attached to a clay body the same amount of moisture should be present in both parts. This is not entirely possible in modeling upon forms which have already been shaped, for if the form be as soft as modeling clay it will not bear to be handled, while if the clay were as hard as the form it could not be worked. A compromise is therefore necessary. The vase must be kept as soft as possible consistent with holding its shape and the clay must be as stiff as the working will allow.

As little water as possible should be used and the modeling should not be brought to its full height at once. If the clay be laid on little by little there is much less chance of cracking. Low relief is sometimes produced by painting in slip but here even more care is necessary. The slip should be laid on with a brush in thin coats, each coat being allowed to stiffen before another is applied and the whole work being kept moist.

An atomizer with clean water is useful in this regard. The work, being kept on a whirler or turntable, is sprayed now and then with water and thus prevented from becoming too hard.

When the slip work has been raised to the desired height the surface is tooled over so as to remove the brush marks. This is the method which has been brought to such perfection by the French artists and by them named *pâte-sur-pâte.*

Modeled work is generally carried out in the same clay as that of which the form is made and depends upon high relief for its effect. Slip painting is usually done in a different color and if a light-colored slip be used upon a dark clay, the latter is partially seen through the coating in the thinnest places. This fact is made use of to accentuate the shadow effects.

In using one clay over another great care must be taken to insure that the fire shrinkage is the same. The white body already given, or indeed, any light colored clay, may be tinted by the addition of underglaze colors. The dry color, if sifted very fine, may be added to the plastic clay by thorough kneading and wedging but it is better to work up the clay into a slip and to stir in the color. The tinted slip is then lawned two or three times and dried out on plaster or used in the slip state as the case may be.

A trial should be made before any important work is undertaken, both to see that the color is right and to discover any discrepancy in shrinkage. If a clay shrinks too much, a little ground flint may be added. If it shrinks too little, a little ball clay will correct it. The tint produced by the color is apt to darken in the kiln but the general hue will be similar to that of the color used.

For some classes of work a native red clay gives admirable results. It may be lightened by the use of kaolin and flint and darkened by adding burnt um-

ber. These colors are more satisfactory than greens and blues in clay because the brown and red tones are natural, the others are artificial.

If a good buff-burning clay be available, it forms the best possible foundation for color work. Burnt umber will darken it and red clay may be mixed with it, always having regard to the matter of shrinkage already mentioned.

Very pleasing effects may be produced by inlaying one clay with another. The pattern or design is first cut out as described under incising and then the second clay is pressed, morsel by morsel, into the excavation. The surface is cleaned off level with the body of the piece and the whole may be either polished or glazed.

A plastic clay can be polished when leather hard and the finish will remain after firing. Any tool of steel, boxwood or ivory will do the work but a good supply of patience is needed so that the whole surface may be uniformly treated.

For color decoration upon the pottery, ordinary underglaze colors are used, either upon the unburned clay or upon the burned ware commonly called biscuit. For use upon the clay, the colors should be mixed in water, using a little molasses, sugar, glycerine or gum arabic to make the color flow easily from the brush. Before burning, a little glaze should be sprayed over the work with an atomizer. Any ordinary fusible

glaze will do. It is diluted with a good deal of water as only the very thinnest coat is necessary. The spray should not be held long in one place or the water will flow and smear the color. If the piece be turned slowly around the clay will absorb the water as it is applied. If this spraying be not done the colors will be apt to rub off after burning. Under-glaze colors are not fusible and hence they come from the fire as dry powders.

The work on the biscuit is much the same except that turpentine and fat oil constitute a better working medium. When dry the spray should be applied as before.

CHAPTER XVII

The Fire

KILNS and burning form the pivot upon which the art of the potter turns. M. Doat has said, "A potter can no more express himself without his kiln than can a violinist without his violin," and yet there are some who try to make out by sending their work to some nearby pottery to be burned. Let it be at once understood that he who finds it impossible to procure and manage a kiln had best take to some other craft.

Kilns are of two types, open and muffle. In the open kiln the flames pass through the firing chamber and the ware may be exposed to their action, as in stoneware and brick; or it may be enclosed in the fire-clay cases, called saggers, as in the many forms of pottery, dishes or faience. The muffle kiln is a closed chamber which is surrounded by flames but which is not entered by them. These kilns are used in the manufacture of terra cotta and heavy enamel wares, and the portable kilns made for studio use are of this type.

There are certain advantages to be gained in the use of either type of kiln but inasmuch as the open

kiln involves the use of saggers and as, moreover, it must be properly constructed of fire-brick by a skilled mason, it will be best to consider only the portable studio kiln.*

It must not be expected that any kiln will give perfect satisfaction. Neither built kiln nor portable kiln will do this, but either may be relied upon to do excellent work in the hands of those who will take trouble. A kiln of the proper size having been purchased, it must be carefully installed. A good chimney is an absolute necessity and if one can be built on purpose it will be best. It should be at least twenty-five feet high with the bottom lined with fire-brick to a height of six or eight feet. The portable kiln is set on iron legs which raise it about one foot from the floor. This is not enough for easy work and a platform of brick or stone, ten inches high, should be prepared. This will greatly simplify the observation and management of the burners which are beneath the kiln, and if it should make the inside of the muffle hard to reach, it is easier to stand on a box to attend to the kiln than it is to go on one's knees to the burner.

The kiln room should have a cement floor and should be both well drained and well ventilated. At the window there should be a stout bench where the

* These kilns are made in several sizes by the H. J Caulkins Company, Detroit, Mich.

work of preparation may be done and at a convenient spot there should be shelves for stilts, cones, wash, stopping and all the minor accessories of burning. If there is room for a barrel of oil it will be a convenience, and if the room be fire-proof the insurance company will not object.

The kiln having arrived it is mounted on the platform and the asbestos-lined pipe is securely connected with the chimney. The inside of the muffle is examined with care to see that no part has been jarred in transit. The reservoir cans are filled with oil and a slow fire is started. This should be allowed to burn very gently for an hour or two in order to thoroughly dry out and season the kiln. It is a good plan to make up a wash of equal parts of kaolin and flint and to brush this all over the inside of the kiln. It should not be put on so thick as to shell off from the walls but at the bottom a good coating may be laid. This protects the walls of the kiln from the attacks of glaze and will make them last longer.

In order to fill the kiln economically a number of props and bats must be provided. Some of these are sent out with the kiln but one is always needing odd sizes and extra pieces. The props are simply legs of burned clay; they are of any height desired and should be thick enough to stand alone. The bats are slabs of burned clay and they rest on the props to form shelves. The bats must be thick enough to bear

the weight of any pieces which they may be called upon to support, but they need not be very large as two or more may be used to bridge the width and length of the kiln. Bats and props are best made of sagger clay to which has been added about one-third of crushed fire-brick. Broken bats serve well for this after the first supply has been secured. This crushed burned clay, called grog, has a very important influence upon wares which have to be heated again and again. The size used should be about what will pass through a 16-mesh sieve, and if the dust be sifted out through a 48-mesh sieve, the resulting ware will be stronger. That is, only the grog which passes a 16 sieve but lies upon a 48 sieve should be used.

The relative proportions of clay and grog in the mix will depend somewhat upon the nature of the clay. Three parts of clay to two of grog by measure will be about right.

The first charging of the kiln should be with pieces of no great importance. The temperature in different parts must be carefully ascertained. In order to do this a number of pyrometric cones* are prepared in groups of three.

Let us suppose that the work is intended to be carried out at a temperature of Cone No. 01. The numbers run both ways from this. The higher or

* The pyrometric cones are fusible pyramids for testing heat. They are made by Prof. Edward Orton, Jr., Columbus, Ohio.

less fusible cones are, 1, 2, 3, 4, etc., up to 36, and the more fusible numbers are 02, 03, etc., down to 022. If the firing is to be to Cone 01, numbers 02, 01 and 1 are selected and set upright in a small strip of soft clay. Eight or ten of these groups of three cones are to be prepared for the first firing, so as to test the kiln, one group is placed in each corner, at the bottom, and another in each corner on a shelf, which is arranged opposite the spy-hole in the door. In the middle of this, where it can be well seen through the hole, one of the groups of cones is placed. They must be set so that all three cones are visible as the kiln is being fired.

The kiln is now filled up on both levels with pieces of pottery. To burn an empty kiln is not a reliable test. On the first occasion the fire should be started in the morning because no one can tell just how long the burn will take. When this time is ascertained it is best to start the fire so that the kiln will be finished by early evening. The cooling then takes place at night and there is no temptation to open the door too soon.

The fire is started slowly and the flow of oil is gradually increased as the muffle begins to glow. The work here needs practice, nerve and judgment. A good deal of smoke will be seen at the chimney at first but this should disappear as the kiln grows red. If the fire be urged too strongly at the beginning fuel

will be consumed to no purpose, the only result being the choking of the flues with carbon. As the red becomes visible through the spy-hole, more oil may be supplied, but notice must be taken that the smoke at the chimney does not increase. The ideal firing is where there is no smoke but this cannot be reached until the kiln is hot enough to cause the smoke to burn.

Persons who have burned kilns for overglaze work will find the method of burning pottery very different. Instead of a fire brought as rapidly as possible to the finishing point, there must now be a slow soaking burn in which the heat shall have time to saturate the ware.

The cones in front of the spy-hole must be observed from time to time and presently as the kiln reaches a bright cherry red, number 02 will begin to bend at the tip and will gradually arch over until the point touches the shelf upon which the cones stand. By this time number 01 will have begun to bend and when the point of this has touched the shelf, the firing is over and the oil is shut off.

It requires some resolution to leave a kiln until morning but it is conducive to early rising anyway. The kiln need not be quite cold but it will help the kiln itself to wear better and the pottery will be better if nothing is done until everything can be handled without gloves.

The cones are now taken out and a diagram is made of each level with the bend of each cone accurately drawn. This diagram should be mounted and hung on the wall for reference. It is not well to trust to memory. It will probably be found, in the type of kiln we are discussing, that the cones on the bottom have bent further than those on the shelf. That is, the bottom is somewhat the hotter.

The variation in the kiln is not necessarily a disadvantage. It may be utilized in burning wares of different kinds. For example, if the bottom prove much the hotter, the biscuit ware may be placed below and the glazed pieces on the shelf. In such case the shelf itself should be washed with a good coating of clay and flint in order to protect it from casual drops of glaze.

If a number of small pieces are being made, more than one shelf should be set up. The legs may be just a little taller than the tallest of the small pieces, but the art of placing or filling a kiln economically consists in making selection of pieces which fit well together both as regards height and shape. Thus, pieces which are large at the base may be dovetailed in with others of which the base is smaller than the upper part. In the case of clay ware the pieces may be set close together or even piled one upon another. There is no danger of sticking unless the ware is

burned to complete vitrification. The glazed pieces must not, of course, touch each other.

It will be seen, from these instructions, that there should be a good assortment of wares from which to select. Economical firing cannot be managed if a burn be attempted whenever a piece is ready, and patience must be exercised so as to fill the kiln to advantage.

It is important that anyone attempting to burn a kiln should have some understanding of the phenomena of combustion. Many things occur in the firing which, without such an understanding, are not easily explained but which become perfectly clear when considered in the light of simple chemical science.

Combustion means oxidation or a combination between the elements of the fuel, principally carbon and hydrogen, and the oxygen of the air. This combination is a chemical action and as it proceeds heat is liberated. With a given amount of a specific fuel and a given amount of air there is always the same amount of heat, but the rate at which this heat is given off varies with the time occupied in the operation. Heat may be generated slowly which means a low temperature, or the same volume of heat may be generated rapidly, occupying a much shorter time and developing a higher temperature. From these statements it will be seen that there is a difference between heat and temperature; heat means volume, temperature

means intensity. Thus the temperature derivable from a given amount of fuel depends upon the rapidity with which it is burned.

Combustion may be either complete or incomplete. In the former case enough air is supplied to oxidize all the fuel with, usually, some excess. The contents of the kiln are then bathed in the heated oxygen and the condition of the burning is called oxidizing. When the combustion is incomplete, on the other hand, there is a deficiency of oxygen. The kiln is charged with hot carbonaceous gases and smoke, and these, being hungry for oxygen, will abstract it from any substance which may be present. This condition is called reducing because the compounds which exist in clay or glaze are deprived of oxygen and thus reduced to a lower state of oxidation.

In burning a kiln one should be able to produce either of these conditions at will because there are certain wares which require one or the other in order to secure the best results. To put the matter in a nutshell, oxidizing conditions are induced by a strong draft and open flues, reducing conditions are obtained by closing the air inlets and using a liberal amount of fuel.

CHAPTER XVIII

High-Temperature Wares

THE subject of "Grand Feu Ceramics" has been so ably developed by M. Taxile Doat in his admirable treatise* that it will be unnecessary to go deeply into the matter, but in order that the reader may be aware of what is involved, some description of the technique wiil be given.

Hard-fired wares are divided into two classes, porcelain and stoneware. The latter is called by the French, "Grès," an abbreviation of the name "Grès de Flandres," the stoneware made in the low countries in the sixteenth century. Both these wares are, technically, once fired, that is, the body and glaze come to maturity at one and the same burning. The biscuit ware is often given a low burn at first in order to facilitate handling, but this leaves the body very porous and is in no sense a maturing fire. The glaze is laid upon this porous ware, or upon the unburned clay if preferred, and then comes the high fire or "Grand Feu" of the French.

A mix for a porcelain body has already been given

* Keramic Studio Publishing Co., Syracuse, N. Y.

but if the ceramist means seriously to attack the porcelain problem he will have to do some experimental work for himself. The Georgia kaolin mentioned in the recipe on page 40 is a good, plastic clay but it is slightly off color. It may be necessary to improve the color by the use, in part, of another kaolin such as the Harris clay from North Carolina.*

Furthermore, in the preparation of a fine porcelain it is necessary to grind the whole mix upon a mill. The mill used for glaze grinding will answer every purpose and care must be taken that the grinding, while carried far enough, be not too long continued. A certain amount of fine grit in the body mass is necessary but only by constant practice can the right point be reached. In making these experiments each step should be faithfully noted in a handy book. The amount of water to a given weight of clay and the duration of the grinding should be accurately observed and written down. It is most unwise to trust to memory.

The process of casting may be used for porcelain as already described, but the very best of workmanship is necessary. The hard fire to which the porcelain is subjected reveals every error which has occurred in the making. The same thing applies to wheel work. Not only is great skill required in order

* The Harris Kaolin Company, Dillsboro, N. C.

to shape the tender porcelain clay on the wheel but the very essence of the porcelain is its lightness, to produce which by craftsmanship a long and arduous course of training must be endured.

Stoneware is free from many of these difficulties and, consequently one who attempts the conquest of high-temperature wares is advised to begin with this. Stoneware clay need not be a mixture. There are many clays which can be used for the manufacture of grès with no more preparation than that laid down for common clays.* It sometimes happens that a clay will need the addition of a small quantity of flint or spar but this does not amount to a difficulty.

Stoneware does not present the same manufacturing difficulties as are found in porcelain. The clay is quite plastic and can be easily shaped on the wheel; casting is scarcely a suitable process for this ware. The essence of stoneware is strength and virility, just as that of porcelain is lightness and grace. Each ware has forms suited to itself and it is a mistake to depart from these essential characteristics.

After shaping and drying the technical manipulation of both wares proceeds along the usual lines. The first fire is at a very low temperature. The melting point of silver (cone 010) is enough in nearly every case. This leaves the ware in a soft and porous

* Stoneware clays may be procured from The Western Stoneware Company, Monmouth, Ill.; H. C. Perrine and Sons, South Amboy, N. J.

condition but hard enough to resist the action of water. The process of glazing has already been described but the composition of the proper glazes differs from that of low temperature glazes.

Porcelain is always burned in a reducing fire; stoneware may be burned either reducing or oxidizing. The temperature at which the glaze is burned is very high, it must be, in fact, the maturing point of the body itself.

The simplest form of porcelain glaze is that represented by the formula—

$$\left.\begin{array}{l} K_2O \ldots\ldots\ldots .3 \\ CaO \ldots\ldots\ldots .7 \end{array}\right\} \quad Al_2O_3 \ldots\ldots\ldots\ldots .5 \quad SiO_2 \ldots\ldots 4.0$$

Which is carried out in the following mixture:

Feldspar	167
Whiting	70
Kaolin	52
Flint	108

The glaze is ground for use.

The same glaze will also serve for stoneware but it will burn to a brilliant surface whereas stoneware is better when finished with a matt texture.

The following is a stoneware matt glaze:

$$\left.\begin{array}{l} K_2O \ldots\ldots\ldots .3 \\ CaO \ldots\ldots\ldots .7 \end{array}\right\} \quad Al_2O_3 \ldots\ldots\ldots\ldots .7 \quad SiO_2 \ldots\ldots 2.6$$

Of which formula the mixture is—

Feldspar	167
Whiting	70
Calcined Kaolin	66
Raw Kaolin	26

The porcelain glaze is at its best when uncolored. The matt glaze will be more interesting when used as a colored coating.

The following are a few suggestions for colored matt stoneware glazes. To the glaze batch, 329 parts, add:

For blue:	
Cobalt Oxide	2 parts
Nickel Oxide	1 part
Ground Rutile	10 parts
For brown:	
Iron Oxide	6 parts
Nickel Oxide	3 parts
Ground Rutile	10 parts
For green:	
Chrome Oxide	2 parts
Cobalt Oxide	1 part
Iron Oxide	4 parts
For dark red:	
Iron Oxide	10 parts
Chrome Oxide	2 parts
Zinc Oxide	6 parts

Rutile has not before been mentioned. It is a crude oxide of titanium and is exceedingly useful in high temperature work for producing odd, mossy and crystalline effects.

These mixtures make no pretense to be complete, they are given as suggestions only because if the artist-potter is to be successful he must be prepared to compound glazes which are the expression of his own individuality.

For burning high-temperature wares the kilns already described may be used but upon purchasing it should be stipulated that the kiln is to stand burning up to cone 11 or 12. Successful porcelain can be made at cone 10 but better results are secured at cone 12, though, of course, the wear upon the kiln is proportionately greater. Stoneware requires a burn of about cone 9, higher or lower according to the clay used but fine results must not be expected below cone 7 nor is it necessary to go higher than cone 10.

CHAPTER XIX

Clay-working for Children

ONE of the modern developments of clay-working is the use of it in elementary and high schools as a branch of manual training. In this, clay meets the most exacting needs of the work for it affords a perfect means of self-expression. Other arts interpose between the pupil and his material a series of tools or appliances, more or less elaborate, which constitute a barrier to the personal touch. Clay presents no such obstacles. The ten fingers are all the tools that are necessary at the beginning and, consequently, the personal equation in clay-working is remarkably high.

In the kindergarten the children take to clay work as little ducks to water and the interest is never lost. In this way, clay, instead of adding to the labors of a teacher already overburdened by a plethora of subjects, constitutes a real relief. The work is so interesting that it moves along of itself and all that is needed is intelligent direction.

It is, of course, necessary that anyone attempting to teach clay-working to children should have a

knowledge of methods and principles. The essence of power, especially in teaching, is reserve, but there is great danger in expecting too much from small heads and hands. In the early exercises the skill of the teacher should even be employed to conceal her art. It is a mistake to place before elementary pupils work which is far beyond their reach. Let the teacher make before the class something which they themselves can do if they try and they will be encouraged to greater effort.

A small cylinder is a suitable beginning exercise for several reasons. The form is definite and the result may therefore be easily criticized by the children themselves, the size of the piece may be readily adapted to the small fingers and the simplicity of line enables the attention to be concentrated upon the manipulation of the clay.

This cylindrical form may be made more interesting by the addition of little feet or handles; by a simple line border incised along the upper edge; or by dividing the surface into well-spaced panels. The planning of the cylinder itself is a good exercise in rectangle proportion.

In order to enable the pupils to turn their work from side to side each one should be provided with a piece of paper or cardboard the size of the base of the pottery. The building is started upon this and,

managed in such a way, the clay does not stick to the table.

When the idea of pottery building, either by coils or by pieces welded together, has been grasped, the children should be taught to think in the solid. There is almost always a difficulty in making children see that an outline drawing and a solid form may be alike in meaning. The teacher should draw upon the blackboard a simple jar in elevation, the plan, of course, will be a circle. The same thing is then made in clay by both teacher and children and the results are compared with the drawing. This will lead to the designing of the forms in outline by the children themselves. These designs should be made the exact size of the proposed pottery and if the outline be carefully cut out the line of the paper may be applied to the work as a template. By such means the children are led to produce accurate lines in the clay and control over the material is secured.

There is always a temptation, when the clay sags or loses shape, to diverge from the original idea and to allow the material to shape itself. This inevitably leads to slovenly work and should be resisted from the first. The paper template helps to correct such an impulse and the pupil presently finds that the clay can be successfully controlled if enough trouble be taken. There is much interest too in the cutting of pottery forms from folded paper. A number of these

forms may be pinned on a screen and the children led to select the best in line and proportion. Too much emphasis cannot be laid on the necessity for showing the children fine examples of pottery, both ancient and modern. The more primitive types, where the form and the decoration are so perfectly adapted to each other and to the material, are full of inspiration for the child potter as well as for the adult. When one is fortunate enough to be near a museum, many illustrations will be found, but good photographs or drawings are available for almost everyone. Constant comparison and the exercise of choice will lead to a development of taste, which must affect the child whether he later becomes a producer or a consumer.

A flower holder is a good problem. It is a solid piece of clay two or three inches in diameter and an inch thick. This may be round or square in form and may have simple modeled decoration added to it. Quarter inch holes are pierced at regular intervals, in fact, they themselves should form part of the design. For the older children a shallow bowl of good line with a flower holder to fit is an interesting problem. Other good problems, which may be made more or less difficult according to the grade in which they are given, are rose jars, bread and milk bowls, incense burners, cylindrical jars, square fern dishes, candlesticks and small lamp bases.

When working out decoration for pottery forms, it is well to have the children make their designs with the modeling tool upon the clay itself. If a piece of soft clay be rolled out flat upon the table it affords the best possible medium for making clay designs. The pupil is at once put in touch with the possibilities and limitations of the material. A drawing made upon paper may have to be entirely changed before it is suitable for use on clay. The soft surface can be smoothed over as often as necessary and a new sketch made until a design is approved for application to the pottery itself. In the chapter on decoration will be found suggestions for clay treatment.

The making of tiles affords an interesting application of the principles of design, but the instructions in the chapter on tile should be followed in order to insure a workman-like product. If it is possible to use plaster, the making of a decorated tile from which a mold can be made and other tiles pressed is a good problem. Animal forms lend themselves to the decoration of such tiles and are always interesting to children.

While these chapters are especially devoted to ceramics in the sense of burned and glazed pottery a few words upon modeling as related to school work may be added here. Imitative modeling from cast or copy with its development of animal and figure modeling, both from life and from memory, is valuable in

the acquirement of the power of manipulation and control as well as in the cultivation of observation, imagination and memory. In the best regulated schools the work of the grades is often correlated in the study of some phase of human life. Facts are grouped around some epoch or event in history or some country or clime in geography. The children take up the clay while their minds are full of the current subject and nothing more natural than that they should illustrate the story by models.

Such work is to be thoroughly commended as truly educational, though it does not fall strictly within the field of pottery and a few suggestions may therefore be in order.

The modeling of animals or people for the sand table is full of interest for the younger children. Such stories as "The Three Bears," "Chicken Little" and "The Little Red Hen" immediately suggest themselves. For children of about the fourth grade "Alice in Wonderland" offers a most fascinating array of models. "The White Rabbit," "The Duchess," "The Mock Turtle," "The Mad Hatter," grotesques of all sorts, seem a natural outcome of this illustration work and the wise teacher will see the possibility for developing the imagination in the modeling of mythical creatures, such as dragons and gnomes, and in the personification of the elements. There is also an un-

limited fund of material in the tales of knighthood and of fairyland.

With the older children, simple principles of design and composition should be suggested. A paper weight is an interesting problem demanding the adaptation of form to space.

Many of these things may be modeled in clay, dried and painted with water color or one of the patent modeling clays which set like cement may be used. If no supports have been left in the model it may be fired when thoroughly dry.

Some of the best projects for sand table work involving modeling are Eskimo Life, Indian Life, Farm Life, The Circus, and Fairy Tales. Generally a suggestion is all that is necessary to call forth the most original conceptions and once started the children will soon far outstrip the teacher.

INDEX

A

B

C

D

E

F

G

H

I

J

K

L

M

O

P